HARTFORD STEAM BOILER
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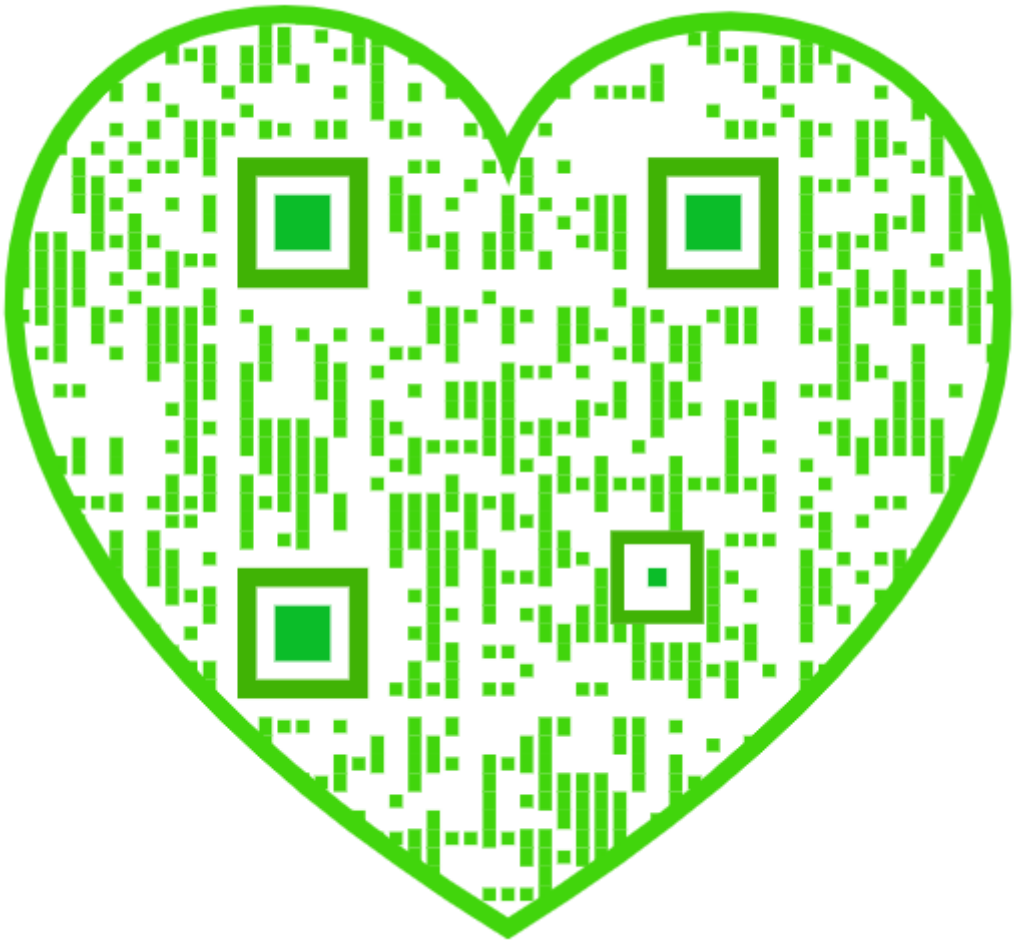

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Mr Andrew Carnegie

The Locomotive.

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NEW SERIES.

Vol. XV.

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The Locomotive.

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The Arrangement of Returns in Heating Systems.

Among the great variety of questions submitted to us regarding the construction of boilers, the installation of steam plants, and the erection of boiler connections and piping, is one in reference to the use of check-valves in the return pipes of heating systems with gravity returns. Usually the amount of detail sent is too little to enable us to

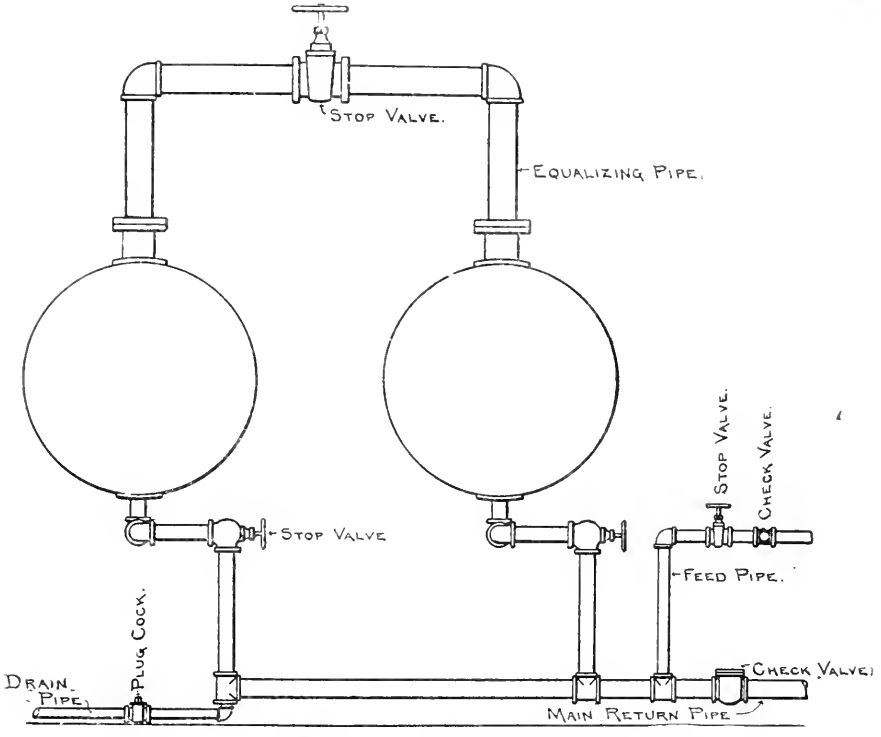

FIG. 1. — ARRANGEMENT OF RETURNS WITH EQUALIZING PIPE.

fully understand the existing condition; but, generally speaking, check-valves should be placed in the main returns near the boiler, so that should failure occur in the piping or radiators the water would not escape from the boiler.

When two or more boilers are used on the same system, and connected with the same return, there is quite a difference of opinion among engineers regarding the

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proper arrangement of check-valves, some contending that the individual return connections to each boiler should have separate checks, while others hold that a check in the main return, before the branch connections are taken off for the separate boilers, is all that is required; this difference of opinion being due to a corresponding difference of opinion respecting the best means of maintaining a uniform water level in all the boilers. Both of these arrangements have good points; and, on the other hand, a partisan of either of them can find objections to the other system, or, in fact, to any system not used by himself. Now, while honest discussion and criticism are proper and legitimate, it might as well be confessed that either arrangement of the checks will be found to work satisfactorily, if the system is otherwise properly designed and proportioned, and properly put together; but the "if" should be given its full emphasis, for with a check in the main return only, and with no equalizing pipe connecting the boilers, there would be great danger of the water backing out from those boilers under which there were good fires, into others having duller fires, or fires that were being cleaned, or that had been freshly coaled. Fig. 1 shows two boilers connected to a common return pipe,

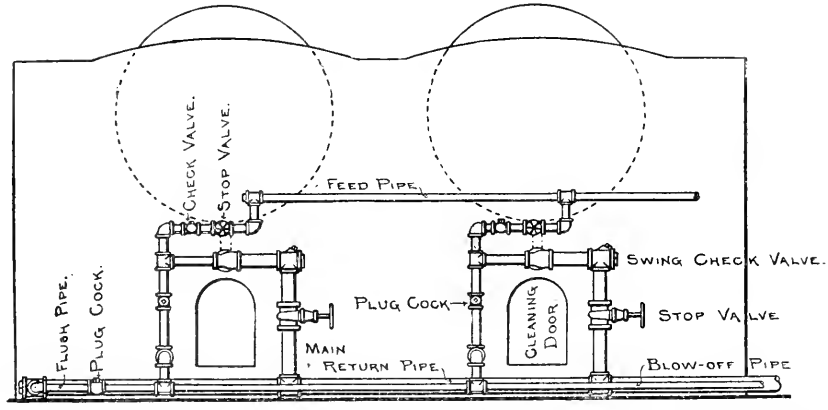

FIG. 2.—ARRANGEMENT OF RETURNS WITH SEPARATE STOP AND CHECK-VALVES.

and having an equalizing pipe between them. This equalizing pipe should be of about the same size as the main steam connections, and should not have steam drawn from it for any purpose. The equalizing pipe should be taken off from the boilers at a point as far removed as practicable from the point of exit of the main steam connection, in order that the pressure in it may be influenced as little as possible by the drafts of steam into the main steam pipe. A valve is placed in the equalizing pipe between the two boilers, to be closed *only* in case one of the boilers is out of use. When both boilers are put into service again, particular care should always be taken to open this valve first. This precaution must never be neglected.

Fig. 2 shows an arrangement of the returns, in which the branch returns to the individual boilers have each a check-valve and a stop-valve, the returns being so located that the pipes can be effectually drained when they are not in use. This latter feature is often overlooked in putting in heating plants, and consequently, when the system is not in use, water is trapped in the pipes, causing their destruction by pitting.

We have had a large experience with heating systems connected in each of the ways shown in the cuts, and with reasonable intelligence and care in the boiler room they have proved equally satisfactory.

Inspectors' Report.

OCTOBER, 1893.

During this month our inspectors made 7,272 inspection trips, visited 14,533 boilers, inspected 5,255 both internally and externally, and subjected 690 to hydrostatic pressure. The whole number of defects reported reached 9,514, of which 1,069 were considered dangerous; 44 boilers were regarded unsafe for further use. Our usual summary is given below:

Nature of Defects.	Whole Number.	Dangerous.
Cases of deposit of sediment,	738	44
Cases of incrustation and scale,	1,432	88
Cases of internal grooving,	94	23
Cases of internal corrosion,	430	29
Cases of external corrosion,	621	43
Broken and loose braces and stays,	141	21
Settings defective,	248	24
Furnaces out of shape,	342	15
Fractured plates,	295	63
Burned plates,	250	23
Blistered plates,	266	18
Cases of defective riveting,	1,228	131
Defective heads,	102	27
Serious leakage around tube ends,	1,641	268
Serious leakage at seams,	484	48
Defective water-gauges,	365	60
Defective blow-offs,	120	34
Cases of deficiency of water,	20	10
Safety-valves overloaded,	71	12
Safety-valves defective in construction,	84	44
Pressure gauges defective,	483	41
Boilers without pressure gauges,	3	3
Unclassified defects,	56	0
Total,	9,514	1,069

Boiler Explosions.

NOVEMBER, 1893.

(252.) — A 100-horse-power boiler exploded, on Nov. 1st, in the Windfall mill, operated by Summerton & Conklin, near Tipton, Ind. Lewis Null, the engineer, was killed. The boiler-house and engine-room were literally demolished, and a great deal of damage was done to the mill. One estimate places the property loss at $25,000. Clayton Summerton, Milton Cox, and Edward Fouche were more or less injured.

(253.) — A terrible boiler explosion occurred on Fourteenth street, New York city, on Nov. 2d. John Armstrong, Thomas Hasson, Samuel McMullen, William Royal, Joseph H. Quinn, Charles Breslin, and James Harlan were killed, and ten or more others received injuries more or less severe. Twenty-five horses were killed outright. The exact amount of the property loss is not known, but it was very large. (A fuller account

of this explosion is given in THE LOCOMOTIVE for December, 1893, where the property loss was estimated at $40,000.)

(254.) — By a boiler explosion in St. Louis, Mo., on Nov. 2d, George Schader, Thomas Scott, and Edward Koepke were instantly killed. The property loss was estimated at $60,000.

(255.) — A boiler exploded in Hogan's mill, in Savannah, N. Y., on Nov. 6th. Lavern Bowler was fatally injured. William Jones was within three feet of the boiler when it exploded, but escaped uninjured, save that he was made totally deaf. Several other persons had similar very narrow escapes. The building was demolished.

(256.) — On Nov. 7th a boiler exploded in the Franklin County Lumber Company's saw-mill at Carrabelle, Fla. The mill was considerably damaged, but no person was injured. The explosion was heard for a long distance.

(257.) — By a boiler explosion on Nov. 7th, at the Elrod mills, at Sand Mountain, near Birmingham, Ala., Richard Elrod and Charles Dickinson were instantly killed, and Robert Bullock and Philip Elrod were fatally injured. The mills were damaged, it is said, to the extent of $20,000.

(258.) — A boiler exploded on Nov. 10th at R. Wallace & Son's factory, at Wallingford, Conn. Several persons had very narrow escapes from death, but there were no fatalities. One man was badly scalded, however. The boiler-house was badly wrecked, and the damage amounted to about $3,000.

(259.) — A boiler exploded on Nov. 10th at the works of the American Strawboard & Paper Co., at Piqua, Ohio. The buildings and machinery were wrecked, the loss being estimated at about $18,000. The boiler crashed through three brick walls, and part of the machinery was hurled almost 200 feet in the air. Ira Grimes, John Galloway, and William Bicknell were injured; and, as there were thirty men at work when the explosion occurred, it is remarkable that the number of injured was no greater.

(260.) — Goeleip's factory, at Kellam's, near Honesdale, Pa., was completely destroyed by a boiler explosion on Nov. 10th. Engineer Charles Kille was killed.

(261.) — A boiler exploded at Palouse, near Garfield, Wis., on Nov. 10th, killing engineer Baker, and badly injuring two other men.

(262.) — By a boiler explosion on Nov. 11th, the electric light plant in Salt Lake City, Utah, was somewhat injured. Fortunately nobody was hurt, and the damage to property was not great.

(263.) — Two large boilers exploded, on Nov. 13th, at Wentz & Co.'s colliery, near Hazelton, Pa. The boilers were blown 100 yards away, and the boiler-house, two toolhouses, and a part of the breaker, were demolished. The fireman had a narrow escape from death. Work at the colliery was suspended.

(264.) — A terrible boiler explosion occurred on Nov. 14th, at Hook's Switch, near Beaumont, Texas. The mill at that place was demolished, and Joseph Kirksy, William Weiss, and Robert McKinney were killed. Six other men were severely injured.

(265.) — On Nov. 17th, a boiler exploded at Herman Eichman's coffee-roasting establishment, in Philadelphia. The property loss was not great, but Mrs. Eichman was so badly scalded and burned that it is doubtful if she can recover.

(266.) — A boiler exploded, on Nov. 18th, in Holliday & Handley's mill, at Dixie,

Ky. Harvey Minton and Cohen Minton were instantly killed. Two other men received injuries.

(267.) — On Nov. 20th, a boiler exploded at the Wisconsin Central pump-house, at Butternut, near Ashland, Wis. Fireman John Linas, and another man whose name we did not learn, were frightfully scalded, and the boiler-house was totally wrecked. There was a report that the damage was due to dynamite that had been maliciously left about the boiler. So far as we could discover, the only ground for this belief was the violence of the explosion. The individual who advanced the dynamite hypothesis had probably never seen a boiler explosion before, and found it hard to believe that steam could be so destructive in its action.

(268.) — A boiler belonging to Mr. John W. Davis, of Jerseyville, Ill., exploded on Nov. 21st. Edward Shellenberger was instantly killed, and two other men received injuries.

(269.) — On Nov. 22d, a boiler exploded at the Oshkosh Art Glass Co.'s works, at Oshkosh, Wis. Nobody was hurt, but the damage to property amounted to $15,000.

(270.) — A boiler exploded in Quincy, Mass., on Nov. 24th, and the engineer, a Mr. Helbom, was blown high in the air. It is thought that his injuries will not prove fatal. The building in which the boiler was located was blown to atoms.

(271.) — A boiler explosion occurred at James's mill, in White Ridge, near Alexandria, Va., on Nov. 24th. Albert Patterson and John W. Lee were killed instantly, and the fireman and another man were seriously burned and bruised. Mr. James, the proprietor of the mill, and a Mr. Pierson, had narrow escapes from death, timbers and portions of the boiler being blown over their heads.

(272.) — The boiler of locomotive No. 604, belonging to the Lehigh Valley railroad, exploded at North Hector, 38 miles from Sayre, Pa., on Nov. 24th. P. H. Billups, the fireman, was killed, and Engineer Cooley and Conductor Henderson were seriously, and perhaps fatally, injured.

(273.) — Richard Brooks was killed on Nov. 25th by the explosion of a boiler in Gadsden, Ala. The building in which the boiler stood was destroyed.

(274.) — A heating boiler exploded in a dwelling-house in Haverhill, Mass., on Nov. 25th. Nobody was hurt, though there were a dozen persons in the house at the time. The building was considerably damaged.

(275.) — By the explosion of a boiler at Clifton, a few miles east of Duluth, Minn., on Nov. 27th, one man was badly scalded and another was blown 100 feet and bruised to some extent. Both will recover.

(276.) — A boiler exploded in Oak Harbor, near Toledo, Ohio, on Nov. 29th, killing Edward Gordon and Edward Monroe, and fatally injuring David Wright.

(277.) — On Nov. 29th, a boiler exploded at the electric light plant in Elwood, Ind., demolishing the entire building, and seriously injuring O. B. Frazier, David Tompkins, Leonard Shively, and W. McMahon.

(278.) — A boiler belonging to Mr. George Wilks, in the town of Lake, near New Coeln, Wis., exploded on Nov. 29th. No person was injured. The damage to property amounted to about $1,000.

(279.) — A locomotive boiler exploded on the Lehigh Valley railroad, at Batavia,

N. Y., on November 29th. Daniel Connors, the engineer, was frightfully scalded from head to foot. He cannot live.

(280.)—On Nov. 30th another locomotive boiler exploded on the Lehigh Valley railroad, this time near Van Etten, a station about 25 miles from Elmira, N. Y. Charles Swartout and "Pearl" Smith were killed.

(281.)—One man was injured, on Nov. 30th, by the explosion of a boiler belonging to ex-Senator Fair, of Knight's Landing, near Woodland, Cal.

(282.)—A boiler exploded, on Nov. 30th, at Shipp's mill, Powder Springs, Ga. Evans Rakestraw was fatally injured, and Westley Rakestraw, James Ivey, and Joseph Shipp were injured seriously, but not fatally.

(283.)—One of the buildings owned by the National Distilling Co., of Milwaukee, Wis., was completely destroyed by a boiler explosion on Nov. 30th. The structure was of brick, 100 feet long, 40 feet wide, and two stories high. It was all blown down except two feet of the walls. The loss was estimated at $10,000.

A Plea for Higher Standards of Materials.

In the latest issue of *The Boiler Maker* there is an article relating to materials for boiler construction, which contains some good thoughts. We reproduce it below, for the benefit of the readers of THE LOCOMOTIVE:

"We fear our readers will tire of a higher standard of quality of material, but the need of some warning voice seems to be one of the demands of the trade. When a boiler-maker can buy his plate for less money per pound than the cost of the beams which go to make up our great buildings, is it not time to call a halt and ask the cause of it? We have inquired of manufacturers why they are making less and less high grade material every year, and we are answered, 'The boiler-makers get just what they ask for and no more.' In turn, we seek for our information from the boiler-maker, and he places the responsibility on the steam-fitter or architect, who prescribes certain physical qualities in his elaborate specifications, and there it ends. And so it seems that the modern rolling mill, costing a fortune, and in its organization embracing the highest skill and intelligence, is to be told by a steam-fitter or other maker of specifications what, and, we were about to say, how, steel plate is to be made and used. How rare is the word 'fire-box' in orders nowadays, and yet the mills are eager to make it.

"We are told that there is a larger profit in high grades of steel, and let us be thankful for that, for by this alone can the manufacturer advance his product. We maintain that the greatest injustice is done the owner of a boiler every time an inferior material is used. He would have none of it if he were given the chance to choose from something better. In the selection of an article of clothing we ask our shoemaker or tailor as to the comparative wearing qualities of his various goods. The question of varying price or durability determines our purchase. But, alas! the boiler-maker is fettered against his judgment, and has but little voice in the determination of what is a suitable article, and by force of circumstances is compelled to look at price alone. The emancipation of the boiler-maker is one of the needs of our trade.

"The terms 'Bessemer' and 'open-hearth' steels, have reference to methods or processes and not necessarily to qualities. If a good quality of pig-iron is made into steel by either the Bessemer or open-hearth process, it would be found that the latter

was softer and more uniform under the stress of severe usage. But Bessemer steel made of good iron is better than open-hearth steel made of a cheap and inferior material. Therefore the Bessemer tank steel of some manufacturers will run better than the open-hearth flange steel of other makers. The name dosn't make the reality."

We have received from the Yorkshire Boiler Insurance and Steam Users' Company, limited, a copy of a report made by Mr. John Waugh to the coroner of the southern division of Leicestershire, Eng., relative to the boiler that exploded on October 25th at Red Hill Quarry, Narborough. The boiler was upright, 9 ft. 8 in. high and 4 ft. 0 in. in diameter. The fire-box was 3 ft. 6 in. in diameter, 5 ft. 8 in. high. It was composed of three plates, $\frac{3}{8}$ in. thick, with vertical seams, and was strengthened with four cross-tubes. The explosion occurred about an hour and a half after the boiler was fired up. A portion of the fire-box was blown out, and the boiler was blown 420 feet from its original place. It was insured by the Manchester company for a pressure of 60 pounds per square inch. Mr. Waugh reports that at the time of explosion it was strong enough to bear the stipulated pressure safely, and he also says that there were no signs of overheating from shortness of water. He concludes that the explosion was caused by simple overpressure. The safety-valve seems to have been unfit for the work it had to do. The valve was not the one originally supplied with the seating, and in order to make the valve fit the seating a "liner" had been put around the "wings" of the valve. The effect of this was to reduce the area of discharge to about one-half of one square inch. Moreover, the proportions of the valve were such that if the ball were at the end of the lever the valve would not rise till the pressure reached 118 pounds, which is practically double what the boiler was allowed to carry. The coroner's jury returned a verdict in accordance with Mr. Waugh's report, and they also blamed the owners of the boiler for not looking after its working condition more sharply. Mr. Waugh's report is illustrated by three plates which give a good idea of the boiler and the safety-valve.

The San Francisco papers have had considerable to say about the boilers in the basement of the City Hall in that place. If all that is said about them is true, they must be extraordinary boilers indeed. One man said he could "take a tack and press it through some parts of them." Another says that "two of the boilers were beyond all repair. They had been patched and were full of holes. A lighted candle could be seen when placed in the interior of the boilers."

Why were these boilers not exhibited at Chicago?

A writer in *Locomotive Engineering* tells of an imposing report made by a locomotive engineer who failed to keep a proper supply of water in his boiler. The crown-sheet was overheated, and extensive repairs were required. The report was as follows: "Owing to a temporary deficiency of dampness on the roof of the furnace of engine 76, the active combustion of carbon produced caloric intensity sufficient to permanently derange the contour of the sheet, suspend active participation of this locomotive in the transportation department, and require the employment of skilled artisans and mechanical appliances unattainable at the time and place of such unsolicited and unexpected derangement of crown-sheet and schedule, caused by procrastination in the application of appliances for the introduction of water to the interior of the boiler."

The Locomotive.

HARTFORD, JANUARY 15, 1894.

J. M. ALLEN, *Editor.* A. D. RISTEEN, *Associate Editor.*

THE LOCOMOTIVE *can be obtained free by calling at any of the company's agencies.*

Subscription price 50 *cents per year when mailed from this office.*

Bound volumes one dollar each. (*Any volume can be supplied.*)

Papers that borrow cuts from us will do us a favor if they will mark them plainly in returning, so that we may give proper credit on our books.

WE desire to acknowledge the receipt from Chief Engineer Guido Perelli of the *Reports* for 1891 and 1892 of the Milan Associazione fra gli Utenti di Caldaie a Vapore.

SOME time ago we had the pleasure of noticing in these pages Mr. Simpson Bolland's *Iron Founder*, and now we have received from Messrs. John Wiley & Sons, of 53 East Tenth street, New York, a copy of another work by the same author. Mr. Bolland calls his new book *The Iron Founder Supplement*, but as it contains about 400 pages and 200 illustrations it would seem as though it were entitled to a more pretentious name. We have read it with considerable profit, and we can commend it to any one interested in iron founding or any of the branches of industry connected therewith.

THE Builders Iron Foundry of Providence, R. I., has favored us with an interesting pamphlet on *The Venturi Meter*, an instrument (if one may call it so) for measuring the flow of water through pipes. It is certainly a unique device. The water does not flow through any measuring apparatus at all, in the ordinary sense of the word. The indications of the meter depend on the general principles of hydraulics pointed out by the Italian philosopher Venturi in 1796; that is, on the "relation between the velocities and pressures of fluids when flowing through converging and diverging pipes."

The Paris Exposition. — Report of the U. S. Commissioners.

We have received from Gen. Wm. B. Franklin, Commissioner-General for the United States, and Vice-President of the Hartford Steam Boiler Inspection and Insurance Company, a copy of the *Reports of the United States Commissioners to the Universal Exposition of 1889*, at Paris. It consists of five volumes. Of these, the first contains the report of the Commissioner-General, with accompanying documents, including reports of officers of the commission, official regulations, classification, and lists of exhibitors and of awards. The second volume contains the reports on the fine arts, on education and the liberal arts, on furniture, textile fabrics, and wearing apparel, on the extractive arts and raw and manufactured products, and on hygiene. The third volume gives the reports on apparatus and processes of mechanical industries and civil engineering. The fourth volume contains the reports on electricity, on military and life-saving material, on alimentary products, and on horticulture; and the fifth and final volume is devoted to agriculture and allied subjects.

We should be pleased to review this most interesting report very fully; but as it contains, in all, over four thousand pages, it will be impossible to give more than a superficial account of it. In his report in the first volume, Gen. Franklin pays a high tribute to the juries that had the task of passing upon the merits of the exhibits. "They worked steadily at all available hours," he says, "until everything exhibited for competition was examined. I have never seen such honest, conscientious hard work as was done by this large number of distinguished men, who served without pay. Their reward was the appreciation by their countrymen and foreign exhibitors of their disinterested labors, and the consciousness — which they have a right to hold — that no body of men ever performed a delicate and laborious task with more industry, with greater ability, and with a better sense of justice to all." We also learn from this report that the number of recompenses of all degrees awarded during the exposition was 33,138. This includes 903 grand prizes, 5,153 gold medals, 9,600 silver medals, 9,323 bronze medals, and 8,070 diplomas of honorable mention. In addition to these, 5,500 medals of various kinds "were awarded to collaborators, workmen who were noted for skill and ability and faithfulness in the work-shops in which the exhibits were prepared." (There were over 60,000 exhibitors in all.) Of these awards, over a thousand were granted to exhibitors from the United States, the awards to this country's exhibits being as follows: Grand prizes, 55; gold medals, 214; silver medals, 300; bronze medals, 246; diplomas of honorable mention, 229. Gen. Franklin, commenting on this list of awards, says: "The United States fared better than any other foreign nation in the number and nature of the awards granted to its exhibitors." He also states that the French estimate of the number of people from the United States that visited Paris during the Exposition is 90,000. It will readily be imagined that multitudes of difficult points were continually coming up before the commission in the discharge of their duties, and that it was an almost impossible task to meet and decide them with the necessary promptness and fairness to all concerned; and one who is in any way familiar with these things will appreciate the following passage from Gen. Franklin's report: "I was well assisted by my subordinates in conducting the business of the commission. As a rule, persons connected with a United States commission to a foreign exposition have no experience in international expositions, and the business is entirely new to them, and requires a certain apprenticeship. By the time the business is learned the exposition is over, and the employes scatter, usually declaring that they will never belong in any capacity to another exposition. The United States commission was no exception to this rule. The business was new to all connected with it, except two or three persons, but it went on as well as that of the other foreign commissioners, and I think creditably to the United States." From the report of Chief Engineer Gunnell we learn that the area covered by Machinery Hall was 654,550 square feet, and that the area covered by the Palace of Liberal Arts was 202,826 square feet. The total floor space occupied by the United States was 113,300 square feet. There are numerous interesting appendices to Gen. Franklin's report, replete with statistical and other information; and the first volume concludes with a very full and complete index, which adds immensely to the value of the report, and to the convenience of the reader. There are also twenty-two excellent engravings.

The second volume of the Report begins with the report on the Fine Arts. We note, on page 19, a vigorous onslaught on the "Angelus," with which we heartily sympathize; but as we know more about boilers than we do about art, it may be that our opinion in this matter is of no great importance. The "Angelus" is a fine painting, but we have seen many that we liked better. The report is illustrated by about a dozen

engravings of paintings and statuary, most of which are excellent. The representation of the "Nymph Echo" is particularly good. Fremiet's "Gorilla and Woman," though it could hardly be called beautiful, is, nevertheless, a powerful and well executed work; and the engraving of it that accompanies the report is very good. Following the report just considered are the reports on Education and the Liberal Arts. It is almost impossible to give any adequate idea of these reports. Prof. Hastings's essay on "Optical Instruments and Optical Materials" is very fine, and no one interested in these subjects should fail to read it. The reports on Furniture and Accessories are very good and complete. In the report on the Products of Mining and Metallurgy there is an account of the manufacture of sodium, which is of considerable interest. The estimated expense of producing this metal by the Castner process is 10½ pence per pound, or about 21 cents. (It is interesting to note, in this connection, that the market price of sodium has recently risen from about 75 cents per pound to $1.75. This is not due to any fault in the process of manufacture. It probably results from a diminished demand for the metal, owing to the fact that aluminium, in the extraction of which it was chiefly employed, is now produced by other means.) In the report on Chemicals and Pharmaceutical Products there is an account of Chardonnet's process for the manufacture of artificial silk. (See THE LOCOMOTIVE for 1893, p. 63.) It appears that the fiber produced by this process can be easily dyed, and that its most objectionable feature (its inflammability) can be overcome by immersing the skeins in dilute nitric acid. It is said that specimens of fabric woven from the artificial silk appear to be "fully equal to true silk in luster and softness." This volume (Vol. 2) contains 141 excellent plates.

The third volume of the Report relates to the apparatus and processes of the mechanical industries, and to railways, civil engineering, public works, and architecture. It is illustrated with 22 plates, and about 300 cuts in the text. In the early part of this volume we read that in the machinery at the Exposition "few absolutely original ideas are to be found. The machinery and apparatus exhibited are little more than recombinations of principles already well-known and applied. Not only would we seek in vain in the vast buildings for some one of those great discoveries which change the character of an industry, but even, in a far more limited sense, inventions which possess a moderately important scope are absolutely wanting. . . . The machines exhibited are, as a whole, better designed and more intelligently combined than those shown in the former expositions; their proportions are better, their workmanship more perfect. In fact, considerable advance has been made. But it is not by great inventions that this progress has been effected; it is rather by a thousand improvements which relate to the details of the machinery." It is gratifying to read, further on, that "no part of Machinery Hall was examined with greater approval by European engineers than was the United States section. The general verdict of these men was that the greater proportion of those machines in which freshness and originality were shown was to be found in this section, and that here the interesting new idea and useful invention were conspicuous above the uniform grade of general excellence everywhere found in the mechanical exhibits." The Commissioner subsequently says that "the representation of the United States was by no means, however, confined to its own section; its proudest display was, in fact, seen outside of the actual exhibits made by its own citizens. Much of the machinery exhibited by the other nations was either admitted to be of design belonging to the United States, and advertised to be this, or else was a close imitation of forms which have originated with its engineers and inventors." Numerous examples of this are given. The reports on mining and metallurgy, on machine tools, on knitting machinery, and on brick and tile machinery cannot be noticed here, further

than to say that they are well worth perusal. The special report on railway plant occupies over 100 pages, and is illustrated by numerous cuts and engravings. In it we notice a reference to the fireless locomotives constructed by the Continental Company of Paris. They are charged with hot water at a temperature of 392° Fah., and they are propelled by the steam this body of water can give off before cooling to 212°. We learn that these locomotives "have been in successful operation for eight years in the Indies, Netherlands, France, England, Austria, and the United States." It would be interesting to know how far they will run before requiring recharging. The report on civil engineering is one of the finest and most extensive of all, and is beautifully illustrated with photo-engravings and wood-cuts.

The fourth volume begins with the report on electricity, in which the many marvelous inventions in this field are described. The accounts of duplex, quadruplex, and multiplex telegraphic systems, by means of which several messages may be sent over the same wire, simultaneously and in both directions, without confusion, will be found interesting to those who do not understand these curious and wonderful applications of electrical principles. The general tendency of the age seems to be to do *everything* by electricity; and it would be impossible to even enumerate the things described and discussed in the report. The report on Military and Life-saving Material comes next in order. It is very comprehensive and very creditable. It is illustrated with about seventy full-page engravings and folding plates. The remainder of this volume consists of the reports on Alimentary Products and on Horticulture. The report on Alimentary Products occupies more than 700 pages, and in it almost every conceivable kind of food material is discussed. It would be rare reading for an epicure seeking for "pointers" about new things to eat.

The fifth volume of the report is devoted exclusively to agriculture and allied subjects, and is replete with interesting and useful information.

In concluding this necessarily imperfect notice of the Report of the United States Commissioners, we must express our appreciation of the enormous amount of hard work its preparation has entailed on General Franklin and his colleagues. They may feel amply repaid for the labor, however, for they have produced a report that surely is not excelled by anything of the kind that has been published in the past. The commissioners to the Columbian Exposition will need to exert themselves to the utmost to come up to the standard these gentlemen have set for them.

The Properties of Steam.

In the issue of THE LOCOMOTIVE for April, 1880, we published a table of the properties of steam, which was based upon what were then the standard authorities on the subject. Since that time other standard works have appeared, and we have thought it well to re-publish the table, after making such changes as would be required to bring it into conformity with the best practice of to-day. The changes are, for the most part, slight and unimportant, and would probably not be appreciable in practical work. The present table, however, is believed to be a little closer to the actual facts than the one published in 1880.

The first and last columns give the pressure of the steam in pounds per square inch, as read by the gauge. It is often assumed, in the construction of tables of this kind, that the pressure as read by the gauge is an even 15 pounds greater than the "absolute pressure." In preparing the present table, however, we have used the more exact value of 14.69 pounds; which is the same as saying that the "gauge pressure" is 14.69

pounds greater than the "absolute pressure." This will vary, of course, with the height of the barometer; but for all ordinary purposes it is not necessary to take account of the barometer, the average pressure being quite accurate enough except in certain refined tests where the utmost accuracy is demanded. Assuming the average pressure of the air to be 14.69 pounds per square inch is the same thing as assuming the average height of the barometer to be 29.95 inches.

The second column needs no especial explanation. It gives the temperatures, on the Fahrenheit scale, corresponding to the pressures in Column 1.

The third column gives the number of cubic feet of steam, at any given pressure, that are obtained when one cubic foot of water (measured at 60° Fah.), is evaporated at the various pressures given in the first column. Since water expands comparatively little when it is heated, this column, for practical purposes, may be considered to give the number of cubic feet of steam produced by each cubic foot of water, whatever the temperature at which the water is measured. In calculating this column, the weight of a cubic foot of water at 60° Fah. has been taken to be 62.367 pounds.

The fourth column gives the weight of one cubic foot of steam at the different pressures, and the fifth column gives the number of cubic feet of steam that weigh one pound.

The sixth column gives the amount of heat required to change a pound of water, at any given temperature, into a pound of steam at the same temperature; and the seventh column gives the total amount of heat that is required to change a pound of water at 32° Fah. into a pound of steam at any given pressure. The "heat unit" referred to, is the amount of heat required to raise the temperature of a pound of water one degree. This is not precisely the same for all temperatures, though it is nearly so, and in most cases it is customary to consider it constant for all temperatures. In the present table the "unit of heat" means the amount of heat required to raise the temperature of a pound of water from 32° Fah. to 33° Fah.

It may be well to illustrate the use of the table by a few examples. Thus, suppose we wished to know how many cubic feet of steam at 85 lbs. pressure would be obtained from 6 cubic feet of water. The table gives 273 as the number of cubic feet of steam from one cubic foot of water. Hence we have $6 \times 273 = 1{,}638$ cubic feet, the answer required. Again, suppose we wished to know how much 40 cubic feet of steam at 120 lbs. pressure would weigh. The table gives .304 of a lb. as the weight of one cubic foot, and hence 40 cubic feet would weigh $40 \times .304 = 12.16$ pounds. If we wanted to know how many cubic feet of steam at 70 lbs. pressure it would take to weigh 100 pounds, we find in the table that it would take 5.09 cubic feet to weigh one pound; and therefore we know that it would take $100 \times 5.09 = 509$ cubic feet to weigh 100 lbs. This would just about fill a cubical box that is 8 feet each way; and yet it must not be supposed that such a box would seem to weigh 100 pounds if it were tried on scales. Such a box, when filled with steam at 70 pounds, would weigh 100 pounds more than it would when it was entirely empty — that is, it would weigh 100 pounds more than it would when it contained neither steam *nor air*. Air buoys up substances that are immersed in it, just as water does; except that it does not buoy them up to the same degree, because it is not so dense as water. A cubic foot of air, under ordinary conditions of temperature and pressure (that is, at 60° Fah. and 14.69 pounds pressure to the square inch) weighs .07634 of a pound; and, conversely, under the same circumstances it takes 13.099 cubic feet of air to weigh a pound. Referring back, therefore, to the first part of the paragraph, we find that the *actual* weight of 40 cubic feet of steam at 120 lbs. pressure is 12.16 pounds. If we wished to

THE PROPERTIES OF STEAM.

Pressure of steam.	Temperature. (Fah.)	Volume and Weight.			Heat.		Pressure of steam.
		Cubic feet of steam from one cubic foot of water.	Weight of one cubic foot of steam.	Cubic feet of steam to the pound.	Latent heat in one pound of steam.	Total heat above 32° in one pound of steam.	
Gauge.	Thermometer.	Cubic Feet.	Pounds.	Cubic Feet.	Heat Units.	Heat Units.	Gauge.
1	2	3	4	5	6	7	8
0	212°	1645	.0379	26.38	966.1	1146.6	0
5	227	1249	.0499	20.03	955.4	1151.2	5
10	239	1010	.0618	16.19	946.8	1154.9	10
15	250	849	.0734	13.62	939.4	1158.1	15
20	259	734	.0850	11.77	933.1	1160.8	20
25	267	647	.0964	10.37	927.4	1163.3	25
30	274	579	.1078	9.28	922.2	1165.5	30
35	281	524	.1190	8.40	917.5	1167.5	35
40	287	478	.1304	7.67	912.7	1169.4	40
45	292	441	.1414	7.07	909.2	1171.1	45
50	298	409	.1524	6.56	905.4	1172.7	50
55	302	381	.164	6.11	901.8	1174.2	55
60	307	357	.175	5.73	898.5	1175.6	60
65	312	336	.186	5.39	895.3	1177.0	65
70	316	317	.196	5.09	892.3	1178.3	70
75	320	301	.207	4.83	889.3	1179.5	75
80	324	286	.218	4.58	886.6	1180.7	80
85	327	273	.229	4.37	883.9	1181.8	85
90	331	260	.240	4.17	881.4	1182.9	90
95	334	249	.251	3.99	878.9	1183.9	95
100	338	238	.261	3.83	876.5	1184.9	100
105	341	230	.272	3.68	874.2	1185.9	105
110	344	221	.282	3.54	872.0	1186.8	110
115	347	213	.293	3.41	869.8	1187.8	115
120	350	205	.304	3.29	867.7	1188.7	120
125	353	198	.314	3.18	865.7	1189.5	125
130	355	192	.325	3.08	863.7	1190.3	130
135	358	186	.336	2.98	861.8	1191.2	135
140	361	180	.346	2.89	859.9	1192.0	140
145	363	175	.356	2.81	858.0	1192.7	145
150	366	170	.366	2.73	856.2	1193.5	150
155	368	165	.377	2.65	854.5	1194.2	155
160	370	161	.388	2.58	852.8	1194.9	160
165	373	157	.398	2.51	851.1	1195.6	165
170	375	153	.408	2.45	849.4	1196.3	170
175	377	149	.418	2.39	847.8	1197.0	175
180	379	145	.429	2.33	846.2	1197.6	180
185	382	142	.441	2.27	844.7	1198.3	185
190	384	138	.450	2.22	843.1	1198.9	190
195	386	136	.459	2.18	841.6	1199.6	195
200	388	133	.467	2.14	840.1	1200.2	200

know the *apparent* weight of this steam we should have to subtract from the actual weight (12.16 pounds) the weight of an equal volume of air. Now since one cubic foot of air weighs .07634 of a pound, it is evident that 40 cubic feet of it will weigh $40 \times .07634 = 3.0536$ pounds. Calling this, in round numbers, 3.05, we have, as the *apparent* weight of 40 cubic feet of steam at 120 lbs. pressure, $12.16 - 3.05 = 9.11$ pounds; which is the weight of the steam as we should obtain it by weighing it in air, on a pair of scales.

We see from the table that up to 15 pounds pressure, or thereabouts, steam is lighter than air; and, consequently, it is not possible for steam of less pressure than this to have any *apparent* weight. At higher pressures steam is denser than air, and its apparent weight can be readily found. Thus to take the same example as before, let us find how many cubic feet of steam, at 70 lbs. pressure, it would take to *apparently* weigh 100 pounds. The *true* weight of one cubic foot of such steam is .196 of a pound, and subtracting from this .076, the true weight of one cubic foot of air, we find that the *apparent* weight of a cubic foot of steam at 70 lbs. is $.196 - .076 = .120$ of a pound, and therefore, to have 100 pounds apparent weight, it would take $100 \div .120 = 833.3$ cubic feet of the steam. This calculation is easily verified: for the absolute weight of 833.3 cubic feet of steam at 70 lbs. is $833.3 \times .196 = 163.3$ pounds, and the absolute weight of the same volume of air is $833.3 \times .076 = 63.3$; and therefore the *apparent* weight of the steam is $163.3 - 63.3 = 100$ pounds, which verifies the calculation.

To illustrate the use of Column 6, let us suppose that it is required to calculate the amount of heat that ten pounds of steam at 40 lbs. pressure will give out, by merely condensing to water, and without subsequent cooling. (This sort of condensation takes place in steam pipes, the water of condensation remaining at the same temperature as the steam around it.) We find from the table that one pound of steam, under the circumstances, would give out 912.7 heat units. Ten pounds, therefore, would give out $10 \times 912.7 = 9,127$ heat units.

If it were required to find the quantity of heat that would be required to transform 12 pounds of water at 46° Fah. into 12 pounds of steam at 110 lbs. pressure to the square inch, we should use Column 7. It appears that 1,186.8 heat units would be required to convert one pound of water at 32° into one pound of steam at 110 lbs. pressure; but as the given feed-water is *already* 14° above 32°, we should need 14 heat units less than the tabular amount of heat; so that the number of heat units required to transform a pound of water at 46° into a pound of steam at 110 lbs. pressure would be $1,186.8 - 14 = 1,172.8$. To evaporate 12 pounds under these conditions we should therefore need $12 \times 1,172.8 = 14,073.6$ heat units.

As a final example in the use of the table, let us find out what is the greatest amount of water that one pound of coal can evaporate, the feed water being at 100° and the steam pressure 70 lbs. The feed water being $100° - 32° = 68°$ above the freezing point, the number of heat units required for each pound of water is $1,178.3 - 68 = 1,110.3$. Now a pound of pure carbon, upon undergoing complete combustion, gives out 14,000 heat units; and if we assume the coal to consist of pure carbon, we find that one pound of it could evaporate $14,000 \div 1,110.3 = 12.61$ pounds of water, under the specified conditions, provided all of its heat could be made available. Of course, no coal consists of pure carbon, and no boiler utilizes all the heat produced under it. We should therefore regard 12.61 pounds merely as a limit that it is not possible to exceed.

THE January issue of *Cassier's Magazine* is of unusual interest and excellence, and it might even be described as an art publication, except that the field of the magazine is engineering. There are, in this issue, for instance, fifteen tinted portraits of distinguished engineers, and over sixty other fine illustrations, most of which are half-tone engravings from photographs, or from what engravers call "wash drawings." But the excellence of the present issue is not by any means confined to the illustrations. There are interesting articles on timely subjects by Messrs. Jackson, Trautwine, Randolph, Leavitt, Emery, Webber, Hutton, Henderson, Cole, Blackwell, Wiley, Thompson, Spies, and Coxe, besides the usual notes on "Current Topics." The issue is decidedly creditable to both editors and publishers.

THERE were many strange things on exhibition at the World's Fair, and there was one in particular that seemed so impossible that many visitors would not believe in its reality, and came away with the impression that they had seen a clever feat of legerdemain; whereas the fact is it was a genuine natural phenomenon, which will doubtless be put to use in the arts. We refer to the experiment shown in the electrical building, where a bar of iron was raised to a welding heat by plunging it into a bucket of water. Several persons have asked our opinion of this astonishing performance, and perhaps an explanation of it would be interesting.

Most of our readers know that water is composed of two substances — oxygen and hydrogen — which are both gaseous when they exist separately, but which condense and produce that familiar liquid when they are united chemically. This may be proved by mixing one volume of oxygen with two volumes of hydrogen, and applying a light to the mixture. It explodes violently, and for this reason the experiment must be performed in a strong vessel. When proper precautions are taken, it is found that there is nothing in the vessel after the explosion but water and steam. The original gases have entirely disappeared, and the new substance (*i.e.*, the water) does not bear the slightest resemblance to either of them.

The composition of water may also be proved by *analysis*. For example, if the two terminal wires of a galvanic battery be dipped into a glass of water, it will be found that bubbles of gas are given off at the negative wire (*i. e.*, the one connected with the zinc end of the battery), and if these bubbles are collected, they will be found to consist of hydrogen. If the positive wire is of platinum, or gold, or some other non-oxidizable metal, bubbles of gas will appear there, too; and upon collecting them we shall find that they consist of oxygen. (If the positive wire is copper, the oxygen bubbles will not be obtained, for the oxygen will unite with the copper as fast as it is liberated, forming oxide of copper.)

In the experiment referred to above, the bar of iron was connected to the negative pole of a powerful dynamo, the other pole of which was connected with the bucket, or with a plate of copper in the bottom of it. The water in the bucket immediately began to decompose, and hydrogen was deposited all over the submerged surface of the iron bar. In a few moments the bar became covered with a film of hydrogen that protected it from contact with the water around it. If the dynamo were not very powerful, the electric current would then cease to flow, because the continuity of the circuit was broken. But as the experiment was arranged at the Fair, the dynamo was so powerful that it overcame the great resistance of the film of hydrogen, and sent its current right through it. Now it is a general fact that heat is produced wherever an electric current encounters a resistance — just as heat is produced in the bearings of an engine when the journal resists the motion of the shaft owing to roughness or grit or bad alignment. Hence the electric current from the dynamo generated great heat in passing through the resistant film of hydrogen that was deposited on the surface of the iron bar; and the dynamo used in the experiment was so powerful that it could produce heat enough to make the bar white-hot in a few moments. The water did not quench the bar, because the hydrogen film prevented the two from coming into actual contact with each other.

It was a remarkable and instructive experiment, and will never be forgotten by those who saw it performed.

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The Locomotive.

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Through Bracing.

In discussing the bracing of boiler heads in previous issues of THE LOCOMOTIVE, we have shown different forms of radial braces, including both the crow-foot, or solid brace, and braces attached to tee-irons, and so placed as to run back to the shell in a direct line from the head fastening, at a proper angle. In the present issue we show a form of "through bracing," in which the braces run from head to head. This type of

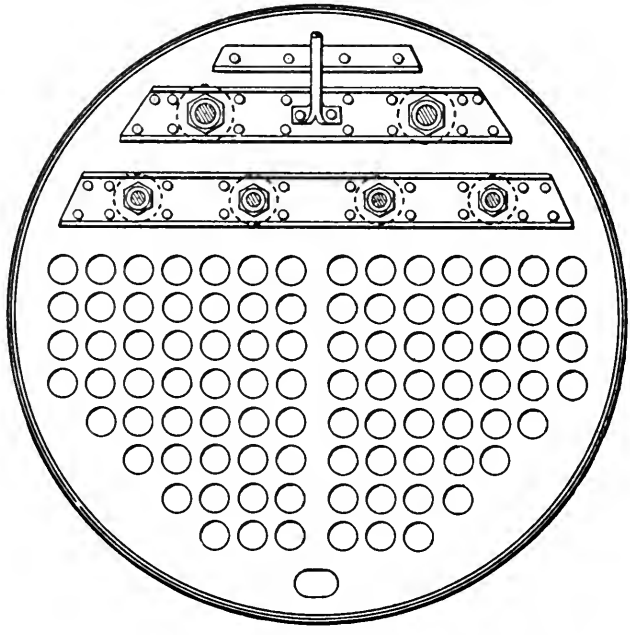

FIG. 1. — A BOILER HEAD WITH THROUGH BRACES.

bracing is in use by several of our large builders of boilers, and with proper design and care in the details of construction, it can be made perfectly tight, and sufficiently strong for the support of the flat surfaces.

In designing these through braces, however, there are important points that must not be overlooked. For example, it is very easy to find a distribution of the braces which would give the same load on each one of them, and also amply stay the heads; but which, nevertheless, would cut off all access to the boiler, and seriously interfere

with making inspections or repairs. The problem of allowing access to the boiler, and still proportioning the bracing so that each brace shall sustain its equable share of the load, may be solved by riveting steel channels to the heads, to serve as washers, or stiffeners, and passing the braces through them, as shown in the illustrations. The braces should be of the best iron, without weld, and should be upset for a distance of six or eight inches from the ends, so that when these ends are threaded the diameter at the bottom of the thread shall slightly exceed the diameter of the main body of the brace. The hole through the head and the channel bars is of such a size as to just admit the enlarged end of the brace, and each brace is secured by a lock nut inside, and a close-

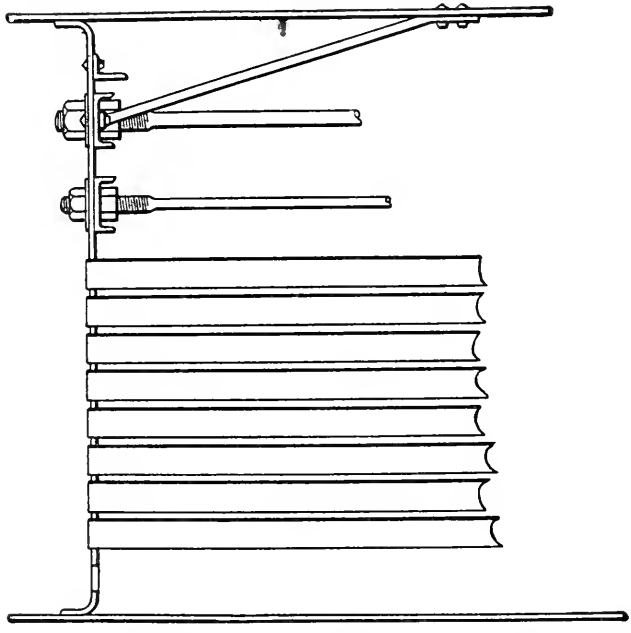

FIG. 2. — SIDE VIEW OF A BOILER HEAD WITH THROUGH BRACES.

fitting copper ring washer and nut on the outside. With proper care in the fitting, a tight joint can be made in this manner, and the head will be held firmly in its natural position.

Six-inch channel-bars are commonly used when bracing is arranged in this manner; but the tendency of the head to buckle between supports is controlled by the spacing of the *rivets*, and we find that a larger channel-bar gives a more equable distribution of the rivets, and consequently a more uniform support to the head.

In this kind of bracing, the number of braces is limited; while with radial bracing the number can be increased to any desired extent. With radial bracing greater strength is obtained by increasing the *number* of the braces. With through braces, on the other hand, increased pressure is provided for by an increase in the *size* of the braces. This is an important consideration; for braces that at 100 pounds pressure sustain a stress of 7,500 pounds per square inch, would not be proper if the boiler were to carry 125 or 150 pounds. The braces should always be proportioned to the surface they have to sustain,

and to the pressure of the steam. It may seem needless to refer to so obvious a fact as this, but our experience has shown that too little attention is sometimes paid to it, and hence we feel called upon to urge its importance.

We shall shortly return to this subject of through bracing.

Boiler Explosions.

DECEMBER, 1893.

(284.) — A boiler exploded in Gallipolis, Ohio, on December 1st, seriously scalding Charles Naul, and breaking his leg. Engineer Charles Clark was also scalded. The boiler was blown over Supt. Rutter's residence.

(285.) — A boiler exploded in Marinette, Wis., on December 2d. The damage was small.

(286.) — On December 3d a boiler exploded in Mannington, W. Va., wrecking six houses and badly scalding a son of James Dewer and a daughter of B. F. Cunningham.

(287.) — Charles Elliot, ——— Beavers, and Frank Spence, were killed on December 4th by a boiler explosion near Eastland, Texas.

(288.) — George Hammond and Joseph Showers were instantly killed, and Joseph Henderson was seriously injured, by the explosion of a boiler in Oxford, N. Y., on December 5th.

(289.) — By a boiler explosion at Oak Harbor, near Fremont, Ohio, on December 6th, W. Gordon, E. E. Monroe, and David Wright were badly scalded. Joseph Giester was also slightly injured. Giester was blown fully fifty feet.

(290.) — E. W. Otis and S. L. White were badly bruised and burned on December 7th, by the explosion of a boiler at Baldwinville, near North Adams, Mass. White is likely to die.

(291.) — A boiler exploded in Warsaw, Ill., on December 7th, fearfully scalding Mr. E. H. Porter, and breaking William A. Cochran's leg.

(292.) — A boiler explosion occurred, on December 8th, at W. E. Moore's saw-mill, near Lynchburg, Va. Fireman William Crews was instantly killed, and Samuel Davis was badly injured. Everything connected with the mill was completely wrecked.

(293.) — A slight boiler explosion occurred on December 9th in the township of What Cheer, Iowa. No person was hurt.

(294.) — By the explosion of a boiler in Brooklyn, N. Y., on December 9th, Alfred Orr and John Clark were badly bruised and scalded.

(295.) — A small boiler exploded on West Fifty-third street, New York, on December 11th. The damage was slight.

(296.) — Wilson Weathersbee was instantly killed on December 12th by the explosion of a boiler in Benton, Ill. Grant Whittington was standing near Weathersbee at the time, and although he was blown into a river, fifty feet away, he escaped serious injury.

(297.) — A boiler exploded on December 14th in Jacksonville, Pa., blowing the boiler-house to pieces, and injuring the engineer.

(298.)—A boiler at Newcastle, Pa., exploded on December 15th, fatally scalding Frederick Gettholtz, and seriously injuring Walker Gaston and Alexander Kerr.

(299.)—The Arcade building at Buffalo, N. Y., was destroyed by fire on December 15th. The fire was caused by an explosion of some kind in the boiler-room; and the loss amounted to over a million dollars.

(300.)—On December 16th a boiler belonging to J. J. Wright exploded in Thackerville, I. T. The boiler-house was demolished, and the machinery of the mill was ruined. Nobody was hurt.

(301.)—By the explosion of a boiler in Navy, W. Va., on December 18th, Allen Brown was killed, and Will Capley, Henry Capley, and Harvey Lewis were injured, the last two fatally so.

(302.)—Two boilers exploded at the Patterson colliery, Mt. Carmel, Pa., on December 18th. William Secano and Michael Hirsch were badly injured. Secano's injuries, in fact, are considered fatal.

(303.)—John W. Knipe and his son were killed, on December 19th, by the explosion of a boiler in Logan, Ohio.

(304.)—A boiler exploded at the Alexandria mills, across the river from Knoxville, Tenn., on December 22d. The plant was completely demolished. Harrison Caldwell, Sherrod Dupees, Louis Palmer, and James Whittle were killed; and Thomas Blair, Solomon Henry, Joseph Massey, James Miller, and James Reese were injured. Blair and Henry have only slight chances of recovering.

(305.)—A boiler exploded in Whitesburg, near Birmingham, Ala., on December 23d. Engineer Benjamin Thomas and Fireman Amos Banks were killed instantly, and three laborers received injuries from which they may die.

(306.)—A boiler exploded on December 28th in McDonald & Dice's mill, near Peru, Ind. George McDonald and his nephew, Richard McDonald, were instantly killed. Walter Dice, one of the owners of the mill, was injured by flying débris; and the mill itself was demolished.

(307.)—A boiler exploded at Point Breeze, near Philadelphia, Pa., on December 29th. The boiler-house was demolished and John Mannes was instantly killed. Robert Mealy was fearfully scalded, and his skull was fractured. It is believed that he cannot recover.

(308.)—On December —— a boiler exploded at St. Rose, St. James parish, La. One man was killed, and five others were frightfully scalded.

THE powers of certain miraculous curative places apparently do not extend to all diseases. W. R. Le Fanu, in his *Seventy Years of Irish Life*, gives the following testimony of an invalid, who had sought the benefits of the Knock Chapel: "Indeed, sir, I took all the rounds and said all the prayers, but it was of no use; not but what it's a grand place; it would astonish you to see all the sticks and crutches hanging up there, left behind by poor cripples who went home cured. It's my opinion, sir, that for rheumatism, and the like of that, it's a grand place entirely; but as for the liver, it's not worth a d —— n."—*Popular Science Monthly.*

Inspectors' Report.

NOVEMBER, 1893.

During this month our inspectors made 6,743 inspection trips, visited 14,706 boilers, inspected 5,241 both internally and externally, and subjected 537 to hydrostatic pressure. The whole number of defects reported reached 10,471, of which 1,058 were considered dangerous; 27 boilers were regarded unsafe for further use. Our usual summary is given below:

Nature of Defects.	Whole Number.	Dangerous.
Cases of deposit of sediment,	810	39
Cases of incrustation and scale,	1,591	65
Cases of internal grooving,	87	7
Cases of internal corrosion,	523	30
Cases of external corrosion,	654	44
Broken and loose braces and stays,	161	39
Settings defective,	229	25
Furnaces out of shape,	361	17
Fractured plates,	345	67
Burned plates,	227	26
Blistered plates,	276	12
Cases of defective riveting,	1,282	113
Defective heads,	93	20
Serious leakage around tube ends,	2,365	322
Serious leakage at seams,	359	29
Defective water-gauges,	331	80
Defective blow-offs,	115	42
Cases of deficiency of water,	11	6
Safety-valves overloaded,	52	11
Safety-valves defective in construction,	80	23
Pressure gauges defective,	471	38
Boilers without pressure gauges,	3	3
Unclassified defects,	45	0
Total,	10,471	1,058

DECEMBER, 1893.

During this month our inspectors made 7,642 inspection trips, visited 15,971 boilers, inspected 6,647 both internally and externally, and subjected 574 to hydrostatic pressure. The whole number of defects reported reached 12,335, of which 1,385 were considered dangerous; 83 boilers were regarded unsafe for further use. Our usual summary is given below:

Nature of Defects.	Whole Number.	Dangerous.
Cases of deposit of sediment,	1,127	71
Cases of incrustation and scale,	2,266	125
Cases of internal grooving,	179	18
Cases of internal corrosion,	776	40
Cases of external corrosion,	887	45
Broken and loose braces and stays,	276	89

Nature of Defects.	Whole Number.	Dangerous.
Settings defective,	291	46
Furnaces out of shape,	410	17
Fractured plates,	430	71
Burned plates,	320	33
Blistered plates,	338	25
Cases of defective riveting,	1,149	80
Defective heads,	165	53
Serious leakage around tube ends,	1,845	346
Serious leakage at seams,	550	62
Defective water gauges,	315	76
Defective blow-offs,	164	44
Cases of deficiency of water,	15	11
Safety-valves overloaded,	97	45
Safety-valves defective in construction,	96	26
Pressure-gauges defective,	601	57
Boilers without pressure-gauges,	3	3
Unclassified defects,	35	2
Total,	12,335	1,385

Summary of Inspectors' Reports for the Year 1893.

During the year 1893 our inspectors made 81,904 visits of inspection, examined 163,328 boilers, inspected 66,698 boilers both internally and externally, subjected 7,861 to hydrostatic pressure, and found 597 unsafe for further use. The whole number of defects reported was 122,893, of which 12,390 were considered dangerous. A summary of the work by months is given below, and the usual classification by defects is likewise given :

SUMMARY, BY DEFECTS, FOR THE YEAR 1893.

Nature of Defects.	Whole Number.	Dangerous.
Cases of deposit of sediment,	9,774	548
Cases of incrustation and scale,	18,369	865
Cases of internal grooving,	1,249	148
Cases of internal corrosion,	6,252	397
Cases of external corrosion,	8,600	536
Defective braces and stays,	1,966	485
Settings defective,	3,094	352
Furnaces out of shape,	4,575	254
Fractured plates,	3,532	640
Burned plates,	2,762	325
Blistered plates,	3,331	164
Defective rivets,	17,415	1,569
Defective heads,	1,357	350
Leakage around tubes,	21,211	2,909
Leakage at seams,	5,424	482
Water gauges defective,	3,670	660
Blow-outs defective,	1,620	425
Cases of deficiency of water,	204	107

Nature of Defects.	Whole Number.	Dangerous.
Safety-valves overloaded,	723	203
Safety-valves defective,	942	300
Pressure gauges defective,	5,953	552
Boilers without pressure gauges,	115	115
Unclassified defects,	755	4
Total,	122,893	12,390

SUMMARY BY MONTHS.

Month.	Visits of inspection.	Number boilers examined.	No. inspected internally and externally.	No. tested hydrostatically.	No. condemned.	Number of defects found.	Number of dangerous defects found.
January,	6,853	14,226	4,702	568	71	10,322	1,040
February,	5,762	11,068	3,820	588	39	8,662	893
March,	7,071	13,943	4,955	737	52	10,454	1,561
April,	6,697	13,018	5,470	723	64	10,432	803
May,	7,300	14,160	6,082	722	52	10,834	919
June,	6,817	13,000	6,118	827	27	10,401	1,005
July,	6,413	10,557	7,711	671	58	11,138	1,039
August,	6,641	15,311	5,292	577	54	9,449	884
September,	6,693	12,835	5,405	647	26	8,881	734
October,	7,272	14,533	5,255	690	44	9,514	1,069
November,	6,743	14,706	5,241	537	27	10,471	1,058
December,	7,642	15,971	6,647	574	83	12,335	1,385
Totals,	81,904	163,328	66,698	7,861	597	122,893	12,390

The following short table shows the increase in the work of our inspectors during the past year :

COMPARISON OF INSPECTORS' WORK DURING THE YEARS 1892 AND 1893.

	1892.	1893.
Visits of inspection made,	74,830	81,904
Whole number of boilers inspected,	148,603	163,328
Complete internal inspections,	59,883	66,698
Boilers tested by hydrostatic pressure,	7,585	7,861
Total number of defects discovered,	120,659	122,893
" " of dangerous defects,	11,705	12,390
" " of boilers condemned,	681	597

The following table is also of interest. It shows that our inspectors have made over three-quarters of a million visits of inspection, and that they have made over a million and a half of inspections, six hundred thousand of which were complete internal inspections. Of defects, nearly a million and a quarter have been discovered and pointed out to the owners; and more than one hundred and fifty thousand of these were, in our opinion, dangerous :

GRAND TOTAL OF THE INSPECTORS' WORK SINCE THE COMPANY BEGAN BUSINESS, TO JANUARY 1, 1894.

Visits of inspection made,	796,725
Whole number of boilers inspected,	1,580,060
Complete internal inspections,	608,786
Boilers tested by hydrostatic pressure,	102,195
Total number of defects discovered,	1,206,309
" " of dangerous defects,	154,749
" " of boilers condemned,	8,406

We append, also, a summary of the work of the inspectors of this company from 1870 to 1893, inclusive. The years 1876 and 1878 are omitted, because the data that we have at hand for those years is not complete. The figures, so far as we have them, indicate that the work during those years was in good accordance with the regular progression observable in other years. Previous to 1875, it was the custom of the company to publish its reports on the first of September, but in this year the custom was changed and the summaries were made out up to January 1st, so as to agree with the calendar year. The figures given opposite 1875, therefore, are for sixteen months, beginning September 1, 1874, and ending December 31, 1875.

SUMMARY OF INSPECTORS' WORK SINCE 1870.

YEAR.	Visits of inspection made.	Whole number of boilers inspected.	Complete internal inspections.	Boilers tested by hydrostatic pressure.	Total number of defects discovered.	Total number of dangerous defects discovered.	Boilers condemned.
1870	5,439	10,569	2,585	882	4,686	485	45
1871	6,826	13,476	3,889	1,484	6,253	954	60
1872	10,447	21,066	6,533	2,102	11,176	2,260	155
1873	12,824	24,998	8,511	2,175	11,998	2,892	178
1874	14,368	29,200	9,451	2,078	14,256	3,486	163
1875	22,612	44,763	14,181	3,149	24,040	6,149	216
1877	.....	32,975	11,629	2,367	15,964	3,690	133
1879	17,179	36,169	13,045	2,540	16,238	3,816	246
1880	20,939	41,166	16,010	3,490	21,033	5,444	377
1881	22,412	47,245	17,590	4,286	21,110	5,801	363
1882	25,742	55,679	21,428	4,564	33,690	6,867	478
1883	29,324	60,142	24,403	4,275	40,953	7,472	545
1884	34,048	66,695	24,855	4,180	44,900	7,449	493
1885	37,018	71,334	26,637	4,809	47,230	7,325	449
1886	39,777	77,275	30,868	5,252	71,983	9,960	509
1887	46,761	89,994	36,166	5,741	99,642	11,522	622
1888	51,483	102,314	40,240	6,536	91,567	8,967	426
1889	56,752	110,394	44,563	7,187	105,187	8,420	478
1890	61,750	118,098	49,983	7,207	115,821	9,387	402
1891	71,227	137,741	57,312	7,859	127,609	10,858	526
1892	74,830	148,603	59,883	7,585	120,659	11,705	681
1893	81,904	163,328	66,698	7,861	122,893	12,390	597

The Explosion on the "Brandenburg."

As we go to press, news is received of a terrible explosion which occurred at Kiel, on February 16th, on the German cruiser *Brandenburg*. The account says: "With the usual secrecy that pervades naval affairs, the officers of the ship refused to give any details regarding the accident, but it is known that many of the crew were killed, and that considerable damage was done to the vessel. The *Brandenburg* had had new boilers placed in her, and had been ordered to make a trial trip to test her. The vessel was on this trip when the explosion occurred. Forty men were instantly killed, and nine others were fatally wounded. Among the dead are three chief engineers who were on the vessel to report on the work of the boilers. Several other officers were also included. Most of the bodies were badly scalded, in some instances the faces being so swollen as to be unrecognizable. As soon as the effects of the explosion were known to the officer of the deck, he caused signals to be set showing that the vessel was helpless. Steamers went at once to the assistance of the disabled war-ship, and, getting lines to her, towed her back to Kiel. When she reached port, Prince Henry of Prussia, the Emperor's brother, immediately boarded her and found that the explosion had caused much damage. The steam tug *Pelican*, which was the nearest vessel, was the first to go to the *Brandenburg's* assistance; and she returned to the quay with thirty dead bodies. The news of the accident had spread through the city, and thousands had gathered at the landing place. Four other steam tugs brought the wounded ashore. Many of the crew were injured critically, and all the injured were taken to the Military Hospital for treatment. Six of these men died on the following morning, making the total number of deaths from the accident forty-six.

"The *Brandenburg* is a steel belted cruiser of 9,840 tons. Her dimensions are: Length, 354 feet 3 inches; beam, 64 feet. She draws 24 feet 7 inches of water. Her engines are of 9,500 indicated horse power, and she has a speed of sixteen knots an hour. She was built at Wilhelmshaven in 1891. From what could be learned from those who would talk of the accident at all, it appears that the main steam pipe of the starboard engine burst while the engines were developing only 7,300 horse power.

"Captain Bendemann of the *Brandenburg* received the following despatch from Emperor William: 'Accept my warmest sympathy and condolence for the loss of our heroes. We must keep a firm trust in God, and submit to the working of His inscrutable will. Then we may find consolation and confidence. I shall cause a tablet commemorating the dead to be placed in the garrison church at Kiel. For those that are left, full steam ahead.'"

So much has been written and said on the cancellation of orders and the return of goods once purchased, that the rights of both seller and buyer are becoming more clearly defined under the law. Both parties have certain rights, and the suits that are occasionally growing out of the infringement of these rights are having a good effect, at least in the way of defining precisely what one can or cannot do under the law. Many retail merchants have an idea that they can refuse to accept goods at any time after ordering. Such would not seem to bet he case under the decision of the Supreme Court of Georgia, in the case of McCord *vs.* Laidley, wherein a firm bought a carload of goods to be shipped and paid for on delivery. The seller shipped the car and forwarded a draft. The draft was presented before the car arrived and payment refused, and the buying firm notified the seller that he had violated the contract by demanding payment before the delivery of the goods, and that they would not accept the goods when they arrived. When the car arrived it was tendered to the buyers and they refused it. It was then sold for what it would bring, which was much less than the contract price. The buyers were held by the court to be liable for the deficit. The decision is not only good law, but sound common sense, and would undoubtedly be cited as a precedent in all similar cases.— *Wade's Fibre and Fabric.*

The Locomotive.

HARTFORD, FEBRUARY 15, 1894.

J. M. ALLEN, *Editor.* A. D. RISTEEN, *Associate Editor.*

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Mr. William Gaston.

It becomes our sorrowful duty to announce the death of ex-Governor William Gaston of Massachusetts, who passed away on January 19th, in the 74th year of his age. Mr. Gaston was an honored and distinguished citizen, and for years had been the State attorney for the Hartford Steam Boiler Inspection and Insurance Company. He was widely known in public life, and was respected by his political opponents as well as by his friends. He was a man of the strictest integrity, and was thoroughly conscientious in all his relations. He was born in Killingly, Conn., on October 3, 1820. He was graduated at Brown University in 1840, and immediately afterwards he began the study of law, being admitted to the bar in 1844. He opened his first law office in Roxbury, Mass., in 1846, and continued his practice there until 1865, when he formed a partnership with Hon. Harvey Jewell and Hon. W. A. Field, and removed to Boston. In 1853 and 1854 Mr. Gaston was elected to the legislature as a Whig, and in 1856 he was re-elected by a fusion of the Whigs and Democrats. In 1861 and 1862 he was mayor of Roxbury, and during that period he was very active in raising troops for the Union cause. In 1868 he was elected to the State senate. In 1871 and 1872 (after the annexation of Roxbury) he was mayor of Boston. It was during his second term as mayor that the great Boston fire occurred; and in the trying times that ensued Mr. Gaston proved the sterling qualities of his character, and amply justified the confidence his friends had reposed in him. In 1874 he was elected governor of Massachusetts. In a notice of his death, the *Boston Herald* justly calls him "an able advocate, an eloquent, forcible speaker, and a thoroughly conscientious man," and adds that "every position to which he was called he successfully filled, and during his long career, occupying many positions of trust, both public and private, the breath of suspicion was never wafted toward him. Men might differ with him politically, but of his thorough honesty and sterling integrity there was but one opinion; and, as was said of him long ago, he was a man pre-eminently qualified for duties requiring 'wisdom, discretion, firmness, and courage when needed, combined with the most exalted integrity and unselfish devotion to the honor, welfare, and prosperity of the city.'"

MR. Edward P. Thompson, whose book ("*How to Make Inventions*") we commented upon a short time ago, writes as follows concerning our criticisms in the December issue: "You remark, 'On page 36 he states that sound moves faster and faster from its source until a certain maximum is obtained. We should like to be referred to the

experiments or equations on which this statement is based.' I refer you, therefore, to Jacques's experiments found described in any standard work on physics. See, for example, Ganot, section 230, as follows: 'He (Jacques) thus found that nearest the gun the velocity (of sound) is least, increasing to a certain maximum which is considerably greater than the average velocity.' You also state, 'On page 44 we read that "water boils in glass vessels at 106° C., and in metal vessels at 100° C. A piece of metal placed in the glass vessel makes the water boil at 100° C."' This would be an extraordinary fact, if it were a fact, which unfortunately it is not.' I refer you therefore to any account of Gay-Lussac's experiments; for example in Ganot, section 366, which gives the same figures, merely adding that the vessels must be chemically clean.

"I can change but cannot improve the wording of a clause you quote from page 33: 'Water vapor in contact with red-hot material is decomposed into hydrogen and oxygen, which are combustible, relatively.' You allege obscurity, especially as to the latter part. The word 'relatively' is necessary to show that hydrogen will burn in oxygen, or oxygen in hydrogen. If 'relatively' were omitted, the inventor might infer that oxygen is combustible in air."

There is a fine irony in referring us to "any standard work on physics" for support of the indefensible proposition about the speed of sound, quoted above. Mr. Thompson's statement was sweepingly made, about sounds in general. He said nothing to his readers about cannon, and so far as any one could judge, he intended the statement to apply to sounds of all kinds. In fact, whenever an unqualified statement about any kind of a wave-motion is made, physicists always understand that the amplitude of the waves is *small;* which was not the case in Jacques's experiments. Moreover, the air in the vicinity of a cannon is thrown into such a violent commotion by the discharge of the cannon, that it would be manifestly unfair to draw conclusions about sound from such experiments, with the expectation that they will be true of sounds *in general.* It is known, for example, that the sound of a cannon-discharge is not propagated with the same speed in all *directions;* yet we imagine that Mr. Thompson would hardly feel justified in modifying this statement so as to make it read "Sound travels with different speeds in different directions."

We even venture the suggestion that Jacques's experiments may not be above reasonable suspicion; though this makes no difference whatever, so far as the foregoing discussion is concerned. Thus he found that with half-pound charges of powder the velocity was 1,032 feet per second at a distance of 40 feet or so from the cannon, and 1,120 feet per second at a distance of about 75 feet. If we make the reasonable assumption that the speed was determined in each case by observing the time required for the sound to travel 40 feet — this is probably the *greatest* distance that would be admissible — we find that the observed time of transmission for velocities of 1,032 feet and 1,120 feet, would be .0388 of a second and .0357 of a second, respectively. The difference between these intervals is .0388 − .0357 = .0031 of a second; hence to *prove* the lesser velocity near the cannon, M. Jacques would have to determine, with precision, an interval of time less than the three-hundredth part of a second. Taking the nature of the experiment into consideration, we should say that this would be practically impossible, even if there were not a cannon banging away all the time at one's elbow.

So far as the boiling-point of water is concerned, let us say that the circumstance (which Mr. Thompson now mentions for the first time) that the experiment will not succeed unless the vessel is "chemically clean," is of the most extreme importance; and a statement in which this condition is omitted is certainly not true. Of course it is well known that water "bumps" when it is boiled in smooth, clean glass vessels; it is also

known that water may be heated much *more* than 6° above the boiling point, if proper precautions are taken. But since it is these very precautions that make the experiments *possible*, statements that do not even remotely suggest that there are any such conditions of success, can only be characterized as misleading and untrue.

Now about the oxygen and hydrogen. If Mr. Thompson had only put *in his book* the explanation he now offers, all would have been clear as day. But the lucid explanation that he now gives does not alter the fact that the original passage was obscure.

Reminiscences of the Fair.

Of the millions of persons who attended the Columbian Exposition, surely there was not one who was not filled with consternation when word came that the Manufactures building was ablaze. On every side there were expressions of sorrow and sympathy for the exhibitors who had not yet removed their goods when the flames burst forth. It is hard to believe that the beautiful peristyle is gone — that in a few short moments it was resolved into its elements and whirled high into the heavens, to exist no more. Visitors who stand where we stood only a little while ago, no longer gaze on those graceful columns and beautiful statues. Nothing is there, now, but desolation.

There may have been men in the beginning who doubted the ability of Chicago to produce an exposition that should excel the Centennial Exposition, and compare favorably with the one so recently held in Paris; but those once dubious must surely now admit their mistake, and acknowledge that Chicago has accomplished all she undertook to accomplish, and that she has given us an Exposition greater and better than any nation has yet produced in the history of the world. Her proud motto, "*I will*," might properly be exchanged for the prouder one, "*I did*."

It was well worth a trip across an ocean and half a continent, to see the buildings and grounds of the White City; and the American people would have been proud to acknowledge the Fair as their own, had there been nothing else on exhibition there. Surely, there is no man who is not thrilled when he looks back at that grand Court of Honor, with its magnificent architectural effects, and beholds, in imagination, the placid waters of the lagoon with the picturesque gondolas and gaily-dressed gondoliers,— the noiseless electric launches flitting about, impelled by some unseen force, — the long lines of electric lamps, threading their way over the great buildings, and sparkling on the ripples of the lagoon, as some saucy, puffing steamboat passed by,— the powerful search-lights wandering about, bringing one object after another into brilliant relief,— and the glories of the luminous fountains, spouting crimson, purple, and golden fire. Such a fairy-like vision was never beheld before, nor ever conceived, save in the imaginative minds of poets.

If one were asked what country made the grandest exhibit there, would he say Italy? or Germany? or Japan? There was a country that made a small exhibit in the Agricultural building. It was a little villa surmounted by a dome, and in it there were olives and pickles. That country was Greece; and when his eye fell upon this exhibit, the visitor, with no thought of disparaging the olives and the pickles, could scarcely refrain from a start of surprise. He asked himself, unconsciously — Can *this* be the exhibit of Greece, the garden of the world, and the home of all that is great and beautiful in art? And when, in contemplative mood, he left the Agricultural building and came out once more into the Court of Honor, and raised his eyes again to

the grandeur of the buildings about him, he exclaimed, "*This* is the exhibit of Greece! She made it possible to design these magnificent structures; and the architectural glories of the Exposition are hers as well as ours."

Without doubt the most impressive exhibit at the fair, aside from the buildings and grounds, was in the electrical department. The advance in this line of investigation could not fail to impress profoundly anyone who had previously seen the Centennial Exposition. A great deal has been written on this subject, during the Exposition and since its close, but we have seen nothing that expresses the facts of the case better or simpler than these words of Prof. Dolbear, in a recent issue of *The Cosmopolitan*. "Then [*i. e.*, in 1876]," he says, "electrical apparatus consisted mostly of telegraphic devices, galvanic batteries, static machines, leyden jars, and measuring instruments such as galvanometers and resistance coils. There were a few crude dynamos and one small imported Gramme machine, none of them intended to maintain more than one arc light. Now there is rivalry for space in which to exhibit dynamos capable of lighting 50 or more in one circuit. Then, there was not a single incandescent lamp in the world. Now, they are to be seen by the tens of thousands, and with all degrees of brightness, from that of a tallow dip to those but little inferior to the arc itself; and every exhibit is thus lighted. Then, there was not a single electrical motor that was more than a toy to be run by a galvanic cell. Now, there are motors for all kinds of service, from driving a fan to those running printing-presses, looms, and machine shops, and threatening the existence of the locomotive itself. Then, all welding was done by hammering at the forge. Now, electricity heats the ends to be joined, and, in less time than it takes to describe the process, heavy shafts and rails may be welded even better than was possible before. Then, it was not possible to weld steel, or other metals than iron. Now, almost any metal may be electrically welded to another, as easily as iron to iron. Then, there were induction coils for producing sparks a few inches long. Now, such sparks have been made five feet long, and it is believed they could be made fifty feet long if it were worth the while. Then, induction coils were employed only for changing low potentials to higher. Now, the transformer reverses the process and makes electric lighting feasible miles away from the dynamo. Then, it was possible to send but two telegraphic messages in opposite directions over the same wire, at the same time. Now, 72 messages can be sent simultaneously over one wire, 36 in each direction, and without the least interference or confusion. Then, the telephone was first exhibited on a line the length of the building. Now, one can talk with another a thousand miles away. Then, it was believed that a continuous conductor was essential for doing any kind of electrical work. Now, it is shown that all kinds of such work may be done without material connections. Then, it was thought that light was one of the physical forces. Now, it is believed that light is an electro-magnetic wave. Then, it was believed and taught that electricity could never be economically employed for driving machinery, and that its light could not be subdivided. Now, it is believed that electricity is in its infancy. Then, all the electrical exhibit could be put in a space 50 feet square. Now, a huge building, covering acres, is found insufficient for the needs of exhibitors. All this since 1876."

There was still another exhibit that attracted the notice of thoughtful visitors, though it was not down on the program. We refer to the deportment of the crowds. It was really inspiring to see a great crowd of American citizens moving about in an orderly manner, and thoroughly on what is sometimes called "their good behavior." Let no cynical reader imagine that we mean to intimate that such a sight is in any way uncommon in smaller assemblies, nor that it is not to be expected in larger ones. We

mean simply that it is not often that we have the opportunity of observing such multitudes of people gathered into one place; and that whenever we *do* have such an opportunity, we find that they behave precisely as we should hope and expect they would. Nevertheless, it makes us proud of them when we behold the fulfilment of our expectations. Even on Chicago Day, when the grounds were thronged almost to their full capacity with tired men and women, if a man inadvertently jostled against you, he begged your pardon and possibly went so far as to raise his hat; and a similar spirit of good nature was everywhere visible.

It was a great Fair.

Canal Works in 1893.

The year 1893 witnessed the completion of the Corinth Canal, a work which may be said to have been in contemplation for the last 2,400 years. The *Engineer*, London, says surveys and borings were actually made, and the work partially commenced, in the reign of the Emperor Nero. The work remained in abeyance till the success of the Suez Canal led to the scheme assuming a practical shape in 1881; and, after overcoming several financial difficulties, the canal was opened for traffic in August last. The length of this canal is only four miles; but the undertaking has been costly, the cutting being principally through rock.

The Manchester Ship Canal was completed during the year, and its opening for traffic was a most notable event. The weather during the year was very favorable to the progress of the works, which were hindered, in previous years, by interruptions caused by floods and tempests. The principal works completed during the year were those for the deviation of the London and Northwestern and Great Western Railways, and the opening of these deviations first for goods traffic and later on for passengers. When this was accomplished there remained the cutting through the site of the old lines. The final completion of this part of the work was considerably delayed by the settlement of the claims of the companies for compensation, which, however, in the end resulted in a favorable award to the canal company, the amount they had to pay being only about one-fourth of that claimed. Several large, swing bridges and the swinging aqueduct at Barton were also completed during the year. The other principal works which have been brought to a successful termination are the embankment of the Mersey, near Runcorn, and the underpinning of Runcorn Bridge. At the end of November the water was let into the last section of the canal, and on December 7th the first steamboat passed from the Mersey, at Eastham, to Manchester. The canal was traversed in 6¼ hours, although there were delays, owing to several of the bridges and the Barton Aqueduct being swung by hydraulic power for the first time. The works were commenced on November 11, 1887, and thus this great undertaking has been completed in the short space of seven years. Meantime, on the lower reach of the canal, business has been rapidly growing, and Saltport, which a year ago hardly had an existence, is now a busy port. From the commencement of 1894, steamers from America will proceed direct to Manchester, and arrangements have been made by different companies for regular traders to Amsterdam, Rotterdam, Antwerp, Dunkirk, Terneuzen, Hamburg, London, Belfast, and other ports.

No further progress appears to have been made for carrying out the Sheffield and South Yorkshire Navigation scheme, and the junction of this system of canals with the Aire and Calder. The scheme, however, is not dead, as a notice has been given by the company of their intention to apply to Parliament for powers to obtain land beyond that which is to be given over by the railway company. The amount to be paid for the ex-

isting canals, which is to be determined by the railway commissioners, has not been settled.

The Panama Canal still remains in a state of ruin. An extension of the concession has been obtained from the Colombian government up to October, 1894, and attempts have been made to form a new company to go on with the work, but, so far, without success. The Nicaragua Canal is also in difficulties. Owing to the state of financial matters in America, it was found impossible to raise money to go on with the work, and in order to protect the works and plant, the Nicaragua Canal Construction Company was placed in charge of a receiver. The company has expended about £800,000 for property, work, labor, and materials, and has, as elsewhere mentioned, recently been reconstructed. The works of the Chignecto Ship Railway Company have been also at a standstill for more than a year, and are going to ruin for want of funds. Over a million of money has been spent, and it is estimated that it will require another half-million to complete the railway.

The North Sea Baltic Canal has been making considerable progress, about 5,000 men being employed, one-half of whom are housed in barracks erected by the canal authorities. A large number of the men are Swiss and Italians, these men being preferred on account of their sober habits. Up to the present time about 100 million cubic yards of earth have been moved. At Holtenau the locks are in working order, and some of the large bridges for carrying the roads and railways over the canal are completed. The estimated cost of this canal is £7,800,000, and it is expected it will be completed in 1894 — seven years after its commencement.

Abroad several important works for improving ports and harbors have been completed during the year. At Tunis a new channel has been opened, from the gulf to the town. At Alexandria a new straight and deep channel has been made to the port. Several important works for the improvement of the harbor of Bilbao have also been completed ; and also at the port of Lido, for improving the navigation to Venice.

In America, the works for connecting Chicago with the Mississippi by means of a canal joining Lake Michigan with the Illinois River are progressing. It is considered that this canal will, for all practical purposes, place the Mississippi cities a thousand miles nearer the Atlantic seaboard, and double the value of the Western lands. The canal on the Canadian side of St. Mary's River, for giving communication between Lakes Huron and Superior, and allowing vessels bound for the St. Lawrence to pass this way instead of through the Sault Ste. Marie Canal, is expected to be completed in July, 1894. This canal is 3,500 ft. long, and will have a lock 900 ft. long, 60 ft. wide, with 19 ft. of water on the sill. The United States at present charges 20 cents per ton on all freight passing through the Sault Ste. Marie Canal and going to any port in the Dominion of Canada, vessels going to the States passing through free. The importance of completing the works, so as to give Canada the control of the great waterway from Lake Superior to the St. Lawrence, is obvious.

At Montreal the works for the improvement of the harbor and the shipping accommodation have made good progress. These consist of a guard pier 1¼ miles long, 45 ft. wide at top, and 20 ft. above low water, extending from the abutment of the Victoria Bridge down stream, for the purpose of protecting the harbor from the floods and the ice. This pier will inclose a basin of 250 acres. The material dredged and excavated from the basin is used for the construction of the pier. Inside this harbor extensive wharves are to be erected. The pier will require about a million cubic yards of materials, of which about one-third is already in place. The estimated cost of this work is £624,000, and it is expected that it will take three years to complete. — *Scientific American.*

Incorporated 1866.

Charter Perpetual.

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The Locomotive.

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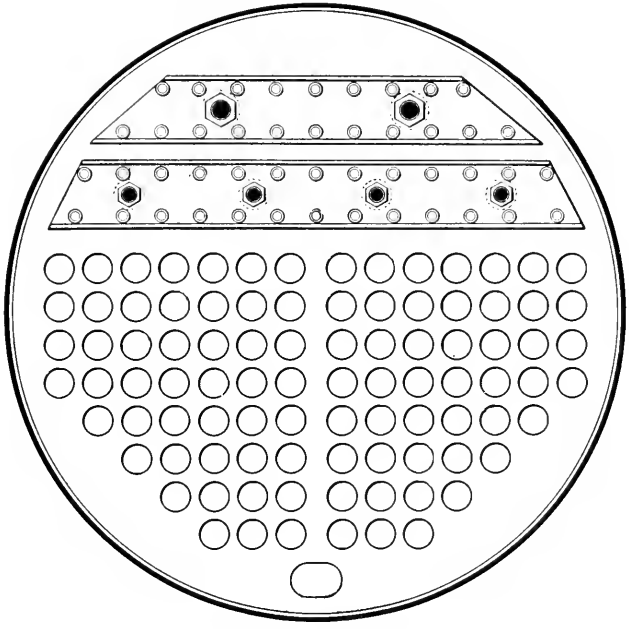
Through Bracing.

In the February issue of THE LOCOMOTIVE we illustrated a method of through bracing, in which the braces were provided with upset ends, and the heads were stiffened by channel bars. The present illustration shows the same general form of bracing as applied to a 72-inch boiler, except that the steel channel bars in the present instance are heavier, and have a width of eight inches; the increased width allowing the rivets to be



ARRANGEMENT OF THROUGH BRACES AND CHANNEL BARS.

spaced in such a way as to provide a more uniform support to the head. The arrangement of the channel bars and the distribution of the rivets must, of course, be governed by the size of the boiler and the amount of steam pressure to be carried. When the pressures are high, a diagonal brace, running to the shell in the usual manner, may be placed between the longitudinal braces on the upper channel bar.

The braces used should be of the best quality of iron, and they will vary in diameter according to the pressure that the boiler is designed to carry. They will also vary, of

course, with the diameter of the boiler, as the area to be braced will be greater in larger boilers than in smaller ones. The arrangement of braces shown in the illustration is designed for a boiler of 72 inches diameter, as we have already said; and in such boilers the diameter of the four lower braces will vary from 1½ inches to 1⅞ inches, and the diameter of the two upper ones from 1⅞ inches to 2¼ inches. These measurements, of course, are for the straight section, or main body of the brace-rods; the upset ends being always in proper proportion to the size of the body of the brace.

To facilitate the selection of proper sizes of through braces, we append the following table, in which the column headed "Strength of the brace," gives the allowable load in pounds, for round braces, based on a tensile strain of 7,500 pounds per square inch of sectional area. The rest of the table will explain itself.

DIMENSIONS AND STRENGTH OF UPSET BRACES.

Diameter of Brace in inches.	Area of cross-section in square inches.	Strength of Brace, in pounds.	Standard diameter for the upset ends.
¾	0.442	3,310	1
⅞	0.601	4,510	1⅛
1	0.785	5,890	1⅜
1⅛	0.994	7,450	1½
1¼	1.227	9,200	1⅝
1⅜	1.484	11,130	1¾
1½	1.767	13,250	1⅞
1⅝	2.073	15,550	2
1¾	2.405	18,040	2⅛
1⅞	2.761	20,710	2¼
2	3.141	23,560	2⅜
2⅛	3.546	26,590	2½
2¼	3.976	29,820	2⅝
2⅜	4.430	33,220	2⅞
2½	4.908	36,810	3

Inspectors' Report.

JANUARY, 1894.

During this month our inspectors made 9,334 inspection trips, visited 17,973 boilers, inspected 6,430 both internally and externally, and subjected 525 to hydrostatic pressure. The whole number of defects reported reached 10,615, of which 1,110 were considered dangerous; 79 boilers were regarded unsafe for further use. Our usual summary is given below:

Nature of Defects.	Whole Number.	Dangerous.
Cases of deposit of sediment,	897	90
Cases of incrustation and scale,	1,749	79
Cases of internal grooving,	92	10
Cases of internal corrosion,	545	33
Cases of external corrosion,	787	60
Broken and loose braces and stays,	170	64
Settings defective,	287	24

Nature of Defects.	Whole Number.	Dangerous.
Furnaces out of shape,	366	18
Fractured plates,	383	67
Burned plates,	315	30
Blistered plates,	232	13
Cases of defective riveting,	1,177	46
Defective heads,	101	23
Serious leakage around tube ends,	1,638	283
Serious leakage at seams,	612	43
Defective water gauges,	368	44
Defective blow-offs,	145	45
Cases of deficiency of water,	24	18
Safety-valves overloaded,	52	15
Safety-valves defective in construction,	83	45
Pressure gauges defective,	519	34
Boilers without pressure gauges,	26	26
Unclassified defects,	47	0
Total,	10,615	1,110

Boiler Explosions.

JANUARY, 1894.

(1.) — A boiler explosion occurred at the Seafield Foundry, Buckie, Ill., on December 19th. Mr. William Adam, the senior proprietor, was killed. [Received too late for insertion in the December list. — ED.]

(2.) — Charles Beckert and Jesse Lang were killed on January 1st, by the blowing out of a screw plug in a boiler in Chattanooga, Tenn. The men were scalded to death.

(3.) — On January 1st, while the big tow-boat *Beaver*, which had come down from Pittsburgh with a tow of coal barges, was at Nine Mile Point, just above New Orleans, La., her auxiliary boiler exploded. Several men were engaged in cleaning out the main boiler at the time. Daniel Gough, the fireman, was fatally scalded, and F. R. Sauverain was slightly injured by the force of the concussion. The property loss was about $1,500.

(4.) — On January 1st, the boiler of engine No. 618, drawing freight train No. 12, bound for St. Louis, exploded at Higgmonson station, forty-five miles north of Little Rock, Ark., on the St. Louis, Iron Mountain & Southern Railway. Head brakeman David Ross was killed instantly, and fireman A. Doolen was badly scalded, and will probably die. The train was made up of thirty-five cars, fourteen of which were loaded with cattle, immediately behind the engine. Four of these cars jumped the track, and nearly all the cattle were killed. Nine cars, in all, were demolished. W. J. Mathews, the engineer, escaped uninjured, although he was blown 100 feet from the engine. Pieces of the engine were found 150 yards from the scene of the explosion.

(5.) — The steamer *Nisbet*, of the Evansville, Paducah & Tennessee River Packet Company, exploded her donkey boiler on January 2d, at Panther Creek, Tenn., sixty-five miles above Paducah, Ky. The front cabin was wrecked, and James C. Mitchell was killed. A number of the passengers and crew were also injured.

(6.)—On January 2d, a small heating boiler exploded in Minneapolis, Minn., doing some damage, but fortunately injuring nobody.

(7.)—A boiler exploded in Beaver Falls, Pa., on January 4th, totally wrecking the building in which it stood. The boiler passed diagonally over two squares, and landed several hundred yards away. The smoke-stack was blown a quarter of a mile through the air. Fortunately nobody was injured. The boiler was a small upright, with a single flue. It was six feet high and 36 inches in diameter, and the plates were of quarter-inch steel.

(8.)—A boiler exploded at St. Charles, Sumter Co., S. C., on January 6th. Mr. John E. Law was blown through the roof of a shed and instantly killed. His body was fearfully mangled. J. J. Luckey, Henry Monaghan, Cantey Bullock, Samuel Solomon, and Moses Perry were badly bruised and scalded.

(9.)—A boiler in Wilson Bros.' mill, in Adelphi, Ohio, exploded on January 11th, blowing the mill to atoms, and instantly killing Noah Hoffman, Silas Wilson, and Amos Stephens. The bodies of Stephens and Wilson were found a mile away. John Wilson was also injured, and it is believed that he cannot recover.

(10.)—The locomotive *Starr King* was blown to pieces at Belmont, N. H., on the Belmont branch of the Concord & Montreal railroad, on January 11th, just as it was leaving the station with a train. Engineer Edward Bowler had his jaw broken and his head crushed, and was dangerously injured in other ways also. Fireman John Ballantyne was horribly scalded about the body and legs.

(11.)—One of the boilers in the City Hall at Philadelphia, Pa., exploded on January 11th, but fortunately nobody was injured, and the building was not materially damaged. The water is said to have been low, so that the fire-sheet became overheated, and blew down.

(12.)—A slight explosion occurred at Tacoma, Wash., on January 13th, at the Crescent Creamery company's building on the ocean dock. Nobody was seriously injured, though Chief Engineer Follette was blown through a door.

(13.)—A boiler exploded on January 13th, in Willy & Co.'s flour mill, at Appleton, Wis. The boiler-house was totally destroyed, and Joseph Barta, the night engineer, was killed. Half of the boiler was blown 500 feet away. The property loss was about $5,000.

(14.)—The boiler of locomotive No. 383, of the "Big Four" railroad, exploded on January 14th, at Winchester, Ind. Albert Rankin, the fireman, was frightfully scalded and bruised, and died in about half an hour. Lafayette Mullin, the engineer, and Edward Dotey, head brakeman, were somewhat injured. An unknown young man, who had just boarded the engine, was also bruised to some extent. The locomotive was totally wrecked.

(15.)—On January 15th the boiler on the ferry-boat *Acorn* exploded at Middleport, near Gallipolis, Ohio. Engineer Joseph Petit was scalded to death, and the boat was badly damaged.

(16.)—One of the boilers in Lukens & Reifsnyder's mill, in Sumter, S. C., exploded on January 15th. John Kennedy was severely injured, but probably not fatally so. Thomas Smith, Ransom Pea, Hampton Carr, Steven Mack, and Simon Witherspoon were also injured. The boiler-house and another adjoining building were demolished.

The whistle belonging to the mill was found about five hundred yards away. The explosion was caused by internal corrosion, which affected only one plate, the others being still sound and good, while the defective one was only a sixteenth of an inch thick in some places. When the explosion occurred the steam gauge indicated only 65 pounds. The property loss was variously estimated at from $7,000 to $10,000.

(17.) — On January 16th a boiler at the breaker of the Reading Company's Indian Ridge colliery at Shenandoah, Pa., exploded and badly damaged the breaker and other buildings. The colliery was necessarily idle for a considerable time, and 780 persons were thrown out of employment.

(18.) — A boiler exploded in Roder's mill, near Sumner, Ill., on January 17th, and Engineer Wilbur E. Smith was killed. Smith was firing up for the day's work. The pipe leading from the boiler to the steam gauge had become clogged, and the gauge registered only 20 pounds. Smith was blown 175 feet, and death was instantaneous.

(19.) — The boiler of a steam tug exploded in Wallabout basin, near New York, on January 17th, and the rear end of the boat was blown away. The tug had been tied up for the night, and there was nobody aboard. The loss was estimated at $3,000.

(20.) — On January 17th, a boiler exploded in J. J. Elliott's mill, near Portsmouth, Ohio. The entire mill was demolished, and Engineer John Stout was fatally scalded. Mr. Elliott was also seriously and perhaps fatally injured. Both of his legs were broken, and it is likely that he received internal injuries in addition.

(21.) — One of the boilers in the Summit mill, at Philmont, N. Y., exploded on January 18th. Virgil Palen was badly cut and bruised, and three others received lesser injuries. The boiler was a new one, and it is said that at the time of the explosion it was carrying only about 35 pounds of steam. Part of the east wall of the building was blown out, and the machinery in the carding room was seriously damaged.

(22.) — On January 18th a boiler exploded at the Cumberland Coal company's mines, near Sturgis, Ky. Engineer George Monroe was killed, his body being frightfully mangled.

(23.) — A boiler exploded on January 22d at Kidd & Shackelford's mill, near Newnan, Ga. William Kidd and Oscar Herring were instantly killed.

(24.) — A slight boiler explosion occurred, on January 23d, in Colorado Springs, Col. The damage was not great.

(25.) — By the explosion of a heating boiler near San Maros, Tex., Herman Heidenheimer and E. Vining were killed, and Roland Simmonds, George Huff, and James Storrs were badly injured.

(26.) — On January 27th, locomotive No. 641, a big eighty-ton engine of the Iron Mountain Company, while standing in the yard at Poplar Bluff, Mo., ready to go out on a trip, exploded her boiler, shaking the earth for two miles. Conductor Chappell was slightly injured.

(27.) — A boiler exploded at the Loomis coal bank, near Wadsworth, Ohio, on January 28th. No one was injured. The damage is not stated.

(28.) — On January 29th, a boiler over a puddling furnace exploded in the Duncannon Iron Company's works, at Duncannon, Pa. One end of the mill and part of the roof were demolished, and J. L. Sommer, Harry Sommer, and Amos High were seriously bruised and scalded.

(29.)—The boiler of a mine locomotive exploded on January 29th at the Cranberry colliery, near Hazleton, Pa. Engineer Adam Greley and Fireman Michael Connell were seriously and perhaps fatally scalded and bruised.

(30.)—A boiler exploded on January 30th at Crow Hickman, a station on the Owensboro & Nashville Railroad, nine miles south of Owensboro, Ky. Taylor Parrish, John Mercer, Robert Slade, Edward Holder, and William Varbele were killed, and James Mercer was fatally injured, and one other man was injured in a lesser degree.

(31.)—A slight boiler explosion occurred in Brooklyn, L. I., on December 9, in the basement of an apartment house in Garfield Place. Alfred Orr was badly bruised and scalded, and John Clark and Harry Grant received lesser injuries. The newspaper account says that "Orr, who had charge of the heating apparatus, had just turned off the safety-valve, as he noticed that the boiler was making too much steam, when the cylinder-head of the boiler blew out" (!)

Explosions of Kitchen Boilers and Heaters.

It is commonly imagined, by those whose attention has not been called to the actual facts, that kitchen boilers and low-pressure heaters do not often explode. It is exceedingly difficult to collect statistics of these accidents in this country, because such boilers are exempt from inspection by the State, and are too frequently not placed under the care of any boiler insurance company; yet we believe that if complete statistics of such explosions *could* be compiled, they would make a most amazing showing. The cause of accidents of this kind has recently been under discussion in the columns of our esteemed English contemporary, *Engineering*, and Mr. Lavington E. Fletcher, Chief Engineer of the Manchester Steam Users' Association, has contributed to it a list of the explosions of this kind that occurred in England and Scotland during a recent "cold snap" that lasted five days. Judging from the difficulty of collecting these statistics, we think it is safe to say that Mr. Fletcher's list contains only a fraction of the total number of explosions that occurred during that period. It is, however, sufficiently imposing as it stands; and it can hardly fail to impress every one who reads it. We give it below:

No. 1. Friday, Jan. 5th, 1894—London, Battersea. Explosion in a dwelling-house, wrecking the kitchen and injuring one man.

No. 2. Friday, January 5th.—London, Upper Norwood. Explosion in a dwelling-house, wrecking the kitchen and killing the maid-servant. Verdict of the coroner's jury, "Accidental death."

No. 3. Friday, January 5th.—London, Central Hill, Norwood. Explosion in a dwelling-house. Side of the house blown completely out.

No. 4. Friday, January 5th.—London, 22 Grafton street, Piccadilly. Explosion in the residence of Lady Mary Scott. A child killed instantly and two women injured.

No. 5. Friday, January 5th.—Lewisham. Explosion in the rooms of the St. James Young Women's Christian Association, wrecking the kitchen and injuring two women.

No. 6. Friday, January 5th.—Brighton. Explosion in a residence, completely wrecking the kitchen.

No. 7. Friday, January 5th.—Birmingham, Edgbaston. Explosion in a dwelling-house, blowing out the kitchen windows.

No. 8. Friday, January 5th. — Worcester. Explosion at Lloyd's bank ; kitchen wrecked completely.

No. 9. Friday, January 5th. — Bognor. Explosion in a dwelling house, completely wrecking the kitchen, and inflicting terrible injuries on a maid-servant, from the effects of which she died next day. Verdict of the coroner's jury, "Accidental death." An engineer who had been working about the house recommended that the fire should be drawn. The jury thought he ought to have seen that his recommendation was acted upon.

No. 10. Friday, January 5th.—Macclesfield. Explosion at Langley Board School. The boiler of the heating apparatus burst, slightly damaging the premises.

No. 11. Friday, January 5th. — Kidderminster. Explosion at the School of Science. The boiler of the heating apparatus burst, blowing down the brickwork and severely injuring the man in charge.

No. 12. Saturday, January 6th.— London, East Finchley. Explosion in a dwelling-house, wrecking the kitchen and killing the cook and housemaid, the one having her arms and neck broken, and the other a portion of her head cut off. A plumber or boiler-fitter had been consulted just prior to the explosion, and he had sanctioned the lighting of the fire. The owner's son was a hydraulic engineer. Verdict of the coroner's jury, "Accidental death."

No. 13. Saturday, January 6th.— Preston. Explosion at Daisy Bank, Ashton-on-Ribble. The kitchen boiler burst while the family were at dinner, wrecking the kitchen and blowing a large hole through the wall of the adjoining house, the fireplace of which was also blown out. A girl nine years old was killed, and three other persons were injured. Verdict of the coroner's jury, "Accidental death." The jury also recommended "that the corporation of Preston be requested to require the owners of all houses to fix safety-valves to all hot-water supply arrangements."

No. 14. Saturday, January 6th.—Liverpool, Lesseps-road. Explosion in a dwelling-house, wrecking the kitchen, blowing the oven through the ceiling, and severely injuring the maid-servant.

No. 15. Saturday, January 6th.— Liverpool, Jermyn street. Explosion in a dwelling-house, demolishing the kitchen and severely injuring the maid-servant.

No. 16. Saturday, January 6th. — Liverpool, Vandyke street. Explosion in a dwelling-house, wrecking the kitchen, and injuring three children who were sitting before the fire.

No. 17. Saturday, January 6th. — Manchester, Knoll street, Higher Broughton. Explosion in a dwelling-house, severely injuring four women.

No. 18. Saturday, January 6th.— Heywood. Explosion in a draper's cellar, setting the shop afire, and doing damage to the amount of $7,500.

No. 19. Saturday, January 6th. — Blackpool, South Shore. Explosion in a dwelling-house, blowing the grate to atoms and injuring two women.

No. 20. Saturday, January 6th.— Leeds. Explosion at the Adel Reformatory. The boiler of the apparatus used for heating the chapel burst, killing two lads who were in charge of it. Verdict of the coroner's jury, "Accidental death."

No. 21. Saturday, January 6th.—Oldham. At the Waterloo street Free Church the boiler of the heating apparatus burst, wrecking the heating chamber and vestry.

No. 22. Saturday, January 6th.— Selkirk. At the Parish church the boiler of the heating apparatus burst, blowing out the doors of the building.

No. 23. Saturday, January 6th.— Glossop. At the Tabernacle Sunday-school the

boiler of the heating apparatus burst, demolishing the outbuilding in which it stood, and doing damage to the extent of $500.

No. 24. Saturday, January 6th.— Coton-in-the-Elms, Staffordshire. At St. Mary's Church the boiler of the heating apparatus burst, considerably damaging the premises.

No. 25. Saturday, January 6th. — High Barnet, Hertfordshire. At the Wesleyan Chapel the boiler of the heating apparatus burst during the night, doing some slight damage.

No. 26. Sunday, January 7th. — Turriff, Banffshire. Explosion in a dwelling-house, wrecking the kitchen and adjoining green-house, and injuring three servants.

No. 27. Sunday, January 7th.— London, Tulse Hill, Lambeth. Explosion in a residence, blowing out doors and windows, demolishing the range, and so severely injuring an elderly woman (the wife of the man in charge), that she died a week later. Verdict of the coroner's jury, "Accidental death." The jury added, however, that they thought all kitchen boilers should be fitted with safety-valves.

No. 28. Sunday, January 7th. — London, 13 Sussex Gardens. Explosion in a dwelling-house, wrecking the kitchen of this house and that of the adjoining one, blowing a hole in the wall between them eight feet by ten, killing the two-year-old son of the man in charge, and seriously injuring two other persons. Verdict of the coroner's jury, "Accidental death." In this case also the jury recommended that safety-valves be placed on boilers of this kind to prevent the recurrence of such explosions.

No. 29. Sunday, January 7th.— Preston, Beech Grove, Ashton-on-Ribble. Explosion in a dwelling-house, blowing out the range and severely injuring a boy.

No. 30. Sunday, January 7th.— Glasgow. Explosion at the Lady Artists' Club, while the family of the fireman was sitting at dinner, wrecking the kitchen, killing the fireman's wife and son, and severely injuring two other persons. As the occurrence was in Scotland, there was no coroner's inquest.

No. 31. Sunday, January 7th.— London, Battersea. At Mantua Street school the boiler of the heating apparatus burst, doing considerable damage.

No. 32. Sunday, January 7th.— Liverpool. At St. Saviour's Schools the boiler of the heating apparatus burst, damaging the building.

No. 33. Sunday, January 7th.— Dundee. At Gilfillan Memorial church the boiler of the heating apparatus burst, damaging the building, blowing out doors and smashing windows, and causing a panic among the children. Fortunately, however, none of them were injured.

No. 34. Sunday, January 7th. — Oldham, Delph. At the Wesleyan chapel the boiler of the heating apparatus burst, firing the chapel and burning it to the ground, the damage being estimated at $25,000.

No. 35. Sunday, January 7th.— Ludlow. At the Police Station the boiler of the heating apparatus burst while a constable was firing it, damaging the premises and injuring the constable.

No. 36. Monday, January 8th.— Darwen. At the Theatre Royal the boiler of the heating apparatus, situated under the auditorium, burst, wrecking the surrounding brickwork.

No. 37. Tuesday, January 9th. — Manchester, Withington. Explosion in a dwelling-house, wrecking the kitchen, blowing out a large portion of the gable end of the house, and severely injuring two women.

No. 38. Tuesday, January 9th.— Bridgenorth. At the Congregational chapel the boiler of the heating apparatus burst, wrecking the interior of the chapel, and seriously injuring two men who were repairing another heating apparatus close by.

This is a professedly incomplete list of the explosions of kitchen boilers and heating boilers, for the *five days* between *Friday*, January 5, and *Tuesday*, January 9, inclusive. It comprises no less than 38 explosions, all of them of boilers that were believed by their owners to be perfectly safe, on account of the low pressures they were supposed to carry. Twelve lives were lost, and thirty-three persons were injured.

Wild Camels in Arizona.

The camels now running wild in Arizona are the descendants of a small herd originally imported for use in the State of Nevada. In the early days of mining on the Comstock, long before there were any railroads in the Great Basin region, it was thought that camels might be profitably used about the mines, particularly in packing across the surrounding deserts, and twelve "ships of the desert" were accordingly purchased and brought to Virginia City. They were wanted for use in packing salt from the Salt Springs salt marsh to the Comstock reduction works. This salt deposit lies far out in a desert region, and to reach it many waterless stretches of sand and alkali had to be traversed.

The camels were able to cross all the deserts in perfect comfort, carrying heavy loads of salt and finding means of subsistence in the prickly and bitter plants and shrubs everywhere to be found in abundance. In short, the animals did as good work here in our deserts as they are able to do in any country in the world, but they were too slow. The camel may be fast enough for an Arab, but he is too slow for an American.

When the occupation of the camels as packers of salt was gone they were sold to some Mexicans, who used them for a time in packing wood down out of the mountains. The Mexicans took them up rocky trails into the rugged hills and used them the same as they used a mule — unmercifully. They soon killed three of the wretched beasts, and would have killed the remainder had not a Frenchman, who owned a big ranch on the Carson River, below Dayton, taken pity on the poor, abused creatures and bought the whole of them. This Frenchman had been in Algeria with the French colony, where he had developed an affection for the camel — probably owing the animal a debt of gratitude for having saved his life on some occasion. He had no use for the beasts, and therefore turned them out to roam the desert plains at will.

The animals, left to shift for themselves, soon waxed fat, and increased and multiplied. In a few years, from nine the herd had increased to thirty-six, old and young. The Frenchman then sold the whole lot to be taken down to Arizona to be used in packing ore down off a big mountain range. It was said there was a good smooth trail, but the animals found all the rocks and soon became footsore and useless, when all were turned adrift to shift for themselves. They have regained the instincts of the original wild state of their species and are very wary and swift. They fly into waterless wastes, impenetrable to man, when approached. Some of the old animals, however, occasionally appear in the vicinity of the settlements. Of late it is reported that the cattlemen have been shooting them for some reason, perhaps because they frighten and stampede their horses. No one knows how many camels are now running at large in the wilds of the Gila country, but there must be a great number. One is occasionally caught. Four years ago one was captured near Gila Bend that measured over nine feet in height. It appeared to be astray from one of the herds in that region.—*San Francisco Chronicle.*

The Locomotive.

HARTFORD, MARCH 15, 1894.

J. M. ALLEN, *Editor.* A. D. RISTEEN, *Associate Editor.*

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The *Report* for 1892 of the Badische Gesellschaft zur Ueberwachung von Dampfkesseln, of Mannheim, Germany, is at hand. It shows the association to be in a flourishing condition.

WE desire to acknowledge a copy of Chief Engineer Sinigaglia's *Calcul de l'epaisseur des chaudières à vapeur.* This essay is very interesting, and we hope shortly to publish an extract from it.

THE fourteenth volume of the *Transactions* of the American Society of Mechanical Engineers has been issued. It is much larger than usual, containing no less than 1,461 pages. It includes the reports of the 26th and 27th meetings, held at New York and Chicago, respectively, and constitutes a valuable addition to the literature of engineering.

THE Hartford Steam Boiler Inspection and Insurance Company has recently secured the services of Mr. L. B. Brainerd, to act in the capacity of assistant treasurer. Mr. Brainerd, in earlier life, has had experience in the fire insurance business as general agent and adjuster, and also as secretary. For the past eight years he has been connected with the Equitable Mortgage Company of New York. He brings to his new position a wide and valuable experience in financial matters.

WE have received from the D. Van Nostrand Company, of 23 Murray street, New York, a copy of Mr. Wm. Paul Gerhard's little book on *Gas Lighting and Gas Fitting.* The first edition of this book was published in 1887. The present edition is considerably enlarged. It includes an article on "Artificial Illumination and the Advantages of Gas," one on "Hints to Gas Consumers," and one on "Specification for Gas Piping." There is also a translation of the municipal rules and regulations regarding gas piping and gas fitting in the city of Munich, Germany. The volume is interesting, and should be useful. It forms No. 111 in Van Nostrand's Science Series, and the price is 50 cents.

FROM the same publishers we have also received a copy of the second edition of Crocker & Wheeler's excellent little book on *The Practical Management of Dynamos and Motors.* The first edition of this book was reviewed on page 136 of THE LOCOMOTIVE

for 1892. The present edition is revised and enlarged, and includes a special discussion of the Thomson-Houston arc dynamo, by Mr. Horatio A. Foster. (205 pp. $1.00.)

Messrs. John Wiley & Sons, of 53 East 10th street, New York, have favored us with a copy of Mr. H. C. Reagan's book on *Locomotive Mechanism and Engineering*. It is a first-class book, and we have read it with much interest. Mr. Reagan writes for the practical locomotive engineer, and his book is full of ideas and suggestions that ought to be useful. He gives special attention to accidents and break-downs, and as what he has to say on this subject is based on his personal experience and observation, his advice can hardly fail to interest all railroad engineers. The book is copiously illustrated. (296 pp. $2.00.)

Professor Alexander Ziwet has kindly sent us the second part of his *Elementary Treatise on Theoretical Mechanics*, the first part of which was noticed in the December issue of The Locomotive. The present volume contains an introductory chapter on dynamics, and the remaining chapters are devoted to statics. It is hardly too much to say that Prof. Ziwet's work bids fair to be the most important contribution to the subject of theoretical mechanics yet produced in this country. The present volume is fully up to the standard set by the first one; and this is the highest praise we could give it. (Macmillan & Co.)

Tiny Steam Engines at the Fair.

There were at least two exceedingly small steam engines on exhibition at the World's Fair. One of these was made by Mr. A. Muller, and loaned by him to the Waltham Watch Company, by whom it was placed on exhibition. It is exceedingly minute, and furnished about power enough to run a watch. A full-sized engraving of it was published in the *Scientific American* for January 13, 1894. We do not know the dimensions of the parts, but the engine is well-proportioned, and is said to be made in the same way as the larger ones that we are all familiar with.

The other pigmy engine was exhibited by Max Kohl, of Chemnitz, Germany, by whom it is called "the smallest steam engine in the world." The dimensions of this microscopic power plant were given in millimeters, and we reproduce them below, both in millimeters and in fractions of an inch.

Length of cylinder,	5.5	mm.	=	0.22	in.
Diameter of cylinder,	2.0	"	=	.08	"
Diameter of flywheel,	10.0	"	=	.40	"
Width of flywheel,	1.5	"	=	.06	"
Length of boiler,	20.0	"	=	.80	"
Diameter of boiler,	8.5	"	=	.34	"
Bore of main steam pipe,	0.4	"	=	.016	"
Length of slide valve,	1.8	"	=	.072	"
Width of slide valve,	1.7	"	=	.068	"
Length of steam ports,	1.3	"	=	.052	"
Width of steam ports,	0.2	"	=	.008	"

The whole apparatus goes inside an English walnut shell, which is hinged to form

a case for it. It was mounted in a glass tube, which was provided with a lens at the upper end, by means of which an enlarged and very good view of the engine and boiler could be had. The engine is horizontal, with the steam-chest on the side. It was fitted with a common ball governor, and the boiler has a lever safety-valve. The workmanship was excellent in every respect.

Foreign Boiler Explosions.

The United States does not have a monopoly in boiler explosions, though of course we hear more of those that occur in this country than we do of foreign ones. Some of the more notable explosions that have occurred recently in other countries are given below.

On January 26th a disastrous explosion occurred in France, at Boulogne sur Seine. The boiler was in a laundry in that city. Several persons were killed and a number of others were buried in the ruins. Many persons were also seriously injured.

A dispatch from Rio de Janeiro, dated February 24th, says that the destruction of the insurgent transport *Mercurio*, which was sunk by the fire of the guns of the government battery at Ponta Madame, is said to have resulted in considerable loss of life to the rebels. The shots which caused the vessel's destruction penetrated her boiler, which burst and killed a number of the insurgents. The ship then caught fire and many of the injured are said to have been burned to death. The transport was still burning fiercely when she sank.

The explosion of a boiler in the iron works at Alexandrovski, Russia, on February 26th, resulted in the death of twenty-five men, and the injuring of many others. Hundreds of workmen are employed near the scene of the explosion, and it was considered marvelous that more were not killed. The boiler let go without a moment's warning, and the fragments flew in every direction. A panic seized the workmen, and those not killed or injured where they stood ran for their lives. Several were struck by the flying fragments as they were running, and were instantly killed. The mill and most of the machinery were badly wrecked.

The Moon of Romance.

The novelists will not leave "the young moon" or "the crescent moon" alone, and three times out of four they contrive to get it into the wrong place. How to explain the conviction which haunts the minds of so many of them, that the crescent moon may be seen almost any fine evening rising gracefully in the east, is altogether beyond us. The point seems to be one for psychologists. Here is a thing that never was seen since the world began: and yet a number of otherwise sane gentlemen are firmly persuaded that it is a regularly recurring natural phenomenon. Surely the philosophy of this hallucination deserves investigation. The last case that has come under our notice is a well-written story called "A Comedy of Masks," by Ernest Dawson and Arthur Moore. Two friends are sitting out one summer evening, looking over the Thames, and the story goes on: "By this time the young moon had risen, and its cold light shimmered over the misty river." A novelist need not be an astronomer, but he should at least try to draw from Nature, and should not pretend to have seen the young moon rising at the very hour when it was being packed off to bed. Some day, perhaps, a little acquaintance at first hand with the broadest facts of Nature will be thought a requisite for writ-

ing a good novel, but the time is not yet. Meantime, if our novelists would try to bear in mind that the young moon, like other young things, goes to bed early — that Nature does not trust it out late at night — they might get into the way of seeing it at the right time and in the right place, and not treat us to "cold shimmers" that are only moonshine in the least favorable sense of the term.

Since the foregoing was put in type our attention has been called to a precisely similar blunder in an article entitled "Notes from a Marine Biological Laboratory," written by a man of science and a college professor, and printed in the February number of this magazine. In the light of what has previously been said, the situation, we must confess, is decidedly awkward, and not at all to the credit of our editorial scrutiny. Yet, while freely admitting that the case is far less excusable than the one cited above, we are still inclined to regard it as an even more emphatic admonition that writers, and particularly writers on scientific subjects, are under obligations to know what they are talking about, and should also be able to subordinate their poetical ambitions to the requirements of truth.— *Popular Science Monthly.*

[The passage referred to above, in the February issue of the *Popular Science Monthly*, is as follows: "It was a beautifully clear and starry night when we sailed into Windward passage. The gray mountains of Cuba outlined against the northern horizon were slowly fading from view, when the crescent moon arose out of the waves in the east." This passage occurs on page 449, and the article was written by Prof. William S. Windle.— ED. LOCOMOTIVE.]

Notes from an Inspector.

An inspector in our northwestern department sends a few notes concerning some things that have recently come under his observation; and as they may interest readers of THE LOCOMOTIVE, we give them below:

"The first case I want to mention relates to overheating of the furnace plates of two boilers in this vicinity. They were each sixteen feet long and 60 inches in diameter, with 44 four-inch tubes, and a man-hole in the front head, under the tubes. These boilers had just been put in, and for ten days they were run very light. They were then started on the regular work, which did not by any means push them to their full capacity. They were run night and day, and their heaviest work was at night. One morning, after they had been running on regular work for about three weeks, they were both found to be badly bagged on the bottom, directly along the front line of the bridge-wall. The bags ran clear across the boilers, and two-thirds of the way up to the water-line. The bulges were greatest at the bottom, where they amounted to about three inches. They extended forward from the bridge-wall for a distance of three or four feet, so that I estimated their area to be about sixteen square feet in each boiler. As soon as I was called on to make an inspection (about 10 A. M.), I went immediately to the boilers and found them in the condition I have described, a new bottom being required in each. One of them was still running, but the fire had been drawn from the other. I had them blow off the boiler that was out of use, so that I could see its condition, inside, just as it was, and before any washing was done. I found the bottom of the boiler heavily covered with a gummy, greasy sediment, about a quarter of an inch thick. It seemed to be organic in nature, and I concluded that it came from the radiators and piping, all of which were new. It would be impossible for any water to get through it, so as to come in contact with the sheets; and the heaviest or thickest part of it was where the sheet was bagged the worst. In the rear part of the boiler,

from the middle of the bridge-wall to the back head, there was a heavy coating of oil, both on the sheets and on the tubes.

"It was easy to see the cause of all the trouble. The building was new, and was heated from top to bottom by exhaust steam from the engines and pumps. They had flooded the engines and pumps with oil, and this oil had been carried all through the building by the exhaust steam, and had been emptied into the boilers together with the sand and other foreign materials contained in the radiators and pipes. (Of course there is always more or less oil and other matter in new work of this kind.) Their mistake was, in not passing all the returns into the sewer for about four weeks, and in being too lavish with oil in the engines and pumps. If they had opened the boilers a couple of weeks sooner, or if they had had their boilers properly inspected, their attention would have been called to the trouble before it was too late. An inspection would have been of especial value to them, as there are many things that may give trouble in starting a new plant. These people had all the best modern appliances, including water-filters and an oil separator; but these were not sufficient to prevent the accident I have described.

"Another thing which I frequently notice in making calls in the way of external inspections, is the neglect of the water connections between the gauge-glass and the boiler. Every engineer is supposed to give his closest attention and care to these connections, but I find that they are sadly neglected by some of the oldest and most experienced engineers. I called at a plant a short time ago, where the engineer had had some years of experience. He had been in this plant for a year. I asked him to blow out the water glass; and after waiting some time for the water to return, I had concluded that it was not going to. Presently, however, it came in sight, and after a considerable time it came up to the proper height in the glass. I asked him to blow it out again, thoroughly; and with my watch in hand I timed its return. It took over five minutes for the water to come in sight. The connection between the boiler and the glass was of one-inch piping. I asked the engineer how large he thought the opening through this pipe was. He said he had not thought about that. It was plain that this trouble had been going on for weeks, and yet he had not discovered how long it took the water to get back into the glass, nor had he given the matter any thought or consideration. If the water only *got* back, that was sufficient. I told him the opening could not be much larger than a knitting needle, and then he began to get his thoughts together. They had an extra boiler, and the one thing on this engineer's mind, for a little while, was to get around fast enough, till he could get this extra boiler ready and shut the other one off and clean out the pipe connections to the water glass. Another case, very similar to this, came under my notice recently, except that it was worse. There were *six* boilers in this battery, and four of the six were in a condition fully as bad as that I have just described; yet the engineer in charge had been in this plant for years, and considered himself well up in engineering.

"Another point I want to speak of, is the importance of having the piping free, between the *steam* gauge and the boiler. Such pipes are often long and small, and with a number of elbows in them. I am frequently called upon to test steam gauges which are all right when the pipes are cleaned out."

STEAM boiler and engine statistics gathered in the German Empire show that, at the beginning of 1893, there were in operation in that country 81,000 stationary boilers and 78,936 stationary engines.— *Power.*

The Cocoanut Tree.

The cocoanut palm is a magnificent plant, well named a "prince of the vegetable kingdom," with tall, slender, columnar stem eighty or one hundred feet high, and rich pale yellow-green leaves which are thirty or forty feet long, and flutter and rustle with every breath of wind. The cocoanut grows only near the shore, where its roots, penetrating the sandy soil, may drink freely from clear, underground springs. Of all trees it is the most useful to man, furnishing food, shelter, and employment to hundreds of thousands of the human race. In tropical countries, especially in southern India and Malaya, the cocoanut supplies to whole communities the chief necessities of life. Every part is useful; the roots are considered a remedy against fevers; from the trunk, houses, boats, and furniture are made; the leaves furnish the thatch for houses and the material from which baskets, hats, mats, and innumerable other articles are made; the network of fibers at their base is used for sieves and is woven into cloth; from the young flower-stalks a palm wine, called toddy, is obtained, from which arrack, a fiery alcoholic drink, is distilled. The value of the fruit is well known. From the husk, which is called coir, commercially, cordage, bedding, mats, brushes, and other articles are manufactured. In the tropics, lamps, drinking vessels, and spoons are made from the hard shells. The albumen of the seed contains large quantities of oil, used in the East for cooking and illuminating; in Europe and the United States it is often made into soap and candles, yielding, after the oil is extracted, a refuse valuable as food for cattle, or as a fertilizer. In some parts of the tropics the kernel of the seed forms the chief food of the inhabitants. The cool, milky fluid which fills the cavity of the fruit when the nut is young affords an agreeable beverage, and the albumen of the young nut, which is soft and jelly-like, is nutritious and of a delicate flavor. As might be expected in the case of a plant of such value, it is often carefully and extensively cultivated in many countries, and numerous varieties, differing in the size, shape, and quality of the fruit, are now known. The cocoanut is propagated by seeds; the nuts are sown in nursery beds, and at the end of six or eight months the seedlings are large enough to plant. The plants are usually set twenty-five feet apart each way, in carefully prepared beds filled with rich surface soil. Once established, a plantation of cocoanuts requires little care beyond watering, which is necessary in its earlier years to insure a rapid and vigorous growth. In good soil the trees usually begin to flower at the end of five or six years, and may be expected to be in full bearing in from eight to twelve years. Thirty nuts from a tree is considered a fair average yield, although individual trees have been known to produce an average of three hundred nuts during a period of ten years. An application of manure increases the yield of the trees, although probably the value of the additional crop obtained in this way is hardly large enough to justify much expenditure. In recent years the cocoanut has been cultivated on a very large scale in British Honduras, Jamaica, and other parts of Central America, as well as on the northern coast of South America and the West Indies. The consumption of cocoanuts in the United States has become very large, as many as twenty millions being imported to this country every year. They are brought largely in steamers with other cargoes, although there are sailing vessels engaged in this trade exclusively, and last month two schooners discharged in this city, respectively, 170,000 and 260,000 nuts.

More than one-half of all the cocoanuts imported are bought by the confectioners, a single firm in New York using as many as forty thousand a month, and it is possible to fill this large standing order because importations are made all the year round. Of the remainder the larger portion goes to the dessicating establishments, while only a few are now sold in the stores in their natural condition. — *Garden and Forest.*

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The Locomotive.

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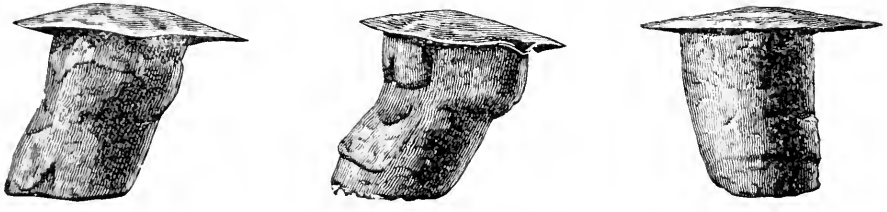
A Case of Defective Riveting.

The driving of rivets is such a comparatively simple operation, that it might be supposed that it would be almost always well done. This is far from being the fact, however, and bad riveting is one of the commonest defects reported by our inspectors. The rivets may be too short, or too long, or too small; they may have heads that are too flat, or they may have projecting "fins," or they may not fill the holes, or the holes may not come "fair" with one another. There are many ways in which riveting may be bad.

A case that recently came to our notice seems to deserve special mention. The rivets in question were in a vertical pulp digester, 10 feet in diameter, and 30 feet high, which was to be so constructed as to be safe under a pressure of 90 pounds to the square inch. The plates were of steel, $\frac{5}{8}$-inch thick, united by lap joints, which were triple riveted on the straight joints, and double riveted on the girth joints. The pitch of the



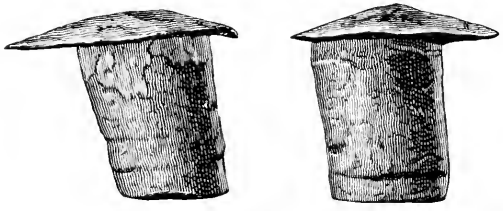
SOME DEFECTIVE RIVETS.

rivets in each case was $3\frac{1}{2}$ inches, and the distance between the parallel rows was 2 inches. The rivets were $\frac{3}{4}$-inch in diameter.

Before the digester was accepted, we were called upon to inspect it and pronounce upon its safety. The inspector found the rivets "driven very low"— that is, the heads were entirely too flat, as shown in the accompanying wood-cuts, which are made directly from photographs of the rivets. He had a number of these rivets taken out, and found that the holes in the two sheets did not come opposite one another fairly. This defect is a common one, and it is very serious, both because it reduces the shearing area of the rivet, and because it greatly increases the difficulty of making the rivets fill the holes perfectly. A shop that turns out work of this kind is particularly censurable, not only because the work itself is poor and weak, but also because the defect is not easy to discover, after the rivets are in place, and the owner of the boiler is therefore likely to be deceived by a fair external appearance, and to carry more pressure than the boiler can safely withstand.

The inspector also found that the heads were not driven evenly over the holes, the centers of the heads often lying well towards the side of the rivet. This defect,

although not so dangerous as the unfairness of the holes, would not be tolerated in a good shop having any pretentions to turning out first-class work. It is very easily detected, even by one who has had little experience in inspecting; and there is no excuse for it, whatever. The rivet holes were not countersunk, as they should be in all good work; and, taking everything into consideration, we think this case presented the finest example of notoriously bad work that we have seen in some time. The only thing that could be done to it, in the way of improvement, would be to cut out all the rivets, ream out the holes until they should be true, and rivet them up again with larger rivets. The most reprehensible thing about the job, perhaps, is that the builder used rivets that he knew to be *too short*. At least, we presume he knew them to be so, for any one who had the smallest idea about the business would know it. A boiler ten feet in diameter, to carry 90 pounds of steam, and with five or six men working about it, cannot be built too carefully; and any such reckless performance as putting in rivets that are too short and too small, comes dangerously near being criminal negligence.



SOME DEFECTIVE RIVETS.

The joint used in this digester is far from being beyond criticism. To begin with, a *lap* joint should not be used at all: a *butt* joint would be much safer, and better in every way. Taking the tensile strength of the plate at 60,000 pounds per square inch, and the shearing strength of the rivets at 38,000 pounds per square inch, a little calculation will show that in the joint that was actually used the rivet area is far too small, so that with $\frac{3}{4}$-inch rivets and a factor of safety of 5, the safe working pressure is only about 56 pounds. If a triple riveted lap joint were used at all, the rivets should be an inch in diameter (holes $1\frac{1}{16}$ inch), and the pitch should be about $3\frac{3}{4}$ inches. This joint gives an efficiency of 72 per cent., and a safe working pressure (with a factor of 5) of just 90 pounds per square inch. But a double welt butt joint is the proper thing for this case.

Inspectors' Report.

FEBRUARY, 1894.

During this month our inspectors made 7,347 inspection trips, visited 15,515 boilers, inspected 5,769 both internally and externally, and subjected 456 to hydrostatic pressure. The whole number of defects reported reached 10,273, of which 1,333 were considered dangerous; 47 boilers were regarded unsafe for further use. Our usual summary is given below:

Nature of Defects.	Whole Number.	Dangerous.
Cases of deposit of sediment,	708	52
Cases of incrustation and scale,	1,601	63
Cases of internal grooving,	69	4
Cases of internal corrosion,	586	44
Cases of external corrosion,	771	58
Broken and loose braces and stays,	189	68
Settings defective,	300	28

Nature of Defects.	Whole Number.	Dangerous.
Furnaces out of shape,	410	17
Fractured plates,	296	62
Burned plates,	193	20
Blistered plates,	218	7
Cases of defective riveting,	1,372	74
Defective heads,	102	27
Serious leakage around tube ends,	1,640	487
Serious leakage at seams,	465	34
Defective water-gauges,	374	92
Defective blow-offs,	148	35
Cases of deficiency of water,	18	9
Safety-valves overloaded,	71	37
Safety-valves defective in construction,	134	37
Pressure gauges defective,	512	47
Boilers without pressure gauges,	18	18
Unclassified defects,	78	13
Total,	10,273	1,333

Boiler Explosions.

FEBRUARY, 1894.

(32.) — On February 2d, the boiler exploded in Warren's mill, at Byer's Corners, near Ottawa, Ont. The engineer, a Swede named John Possette, was injured so seriously that he is not expected to live. The boiler is said to have been found "about three acres from where it was stationed," however far that may be.

(33.) — A boiler exploded on February 2d in E. R. Ulrich & Son's elevator, at Dawson, Ill. Jerry Baugh and his little boy, who were in the elevator at the time, were scalded badly. It was at first believed that both would recover; but, on February 11th, the boy was taken with tetanus, and, at last accounts, it was considered certain that he would die.

(34.) — On February 9th, a boiler belonging to Mr. Isaac Atyeo of Ripley township, near Norwalk, Ohio, exploded. Mr. Mack Atyeo was killed, and Vernon Atyeo and Frederick Guess were badly scalded and otherwise injured, but will recover.

(35.) — Two boilers exploded on February 10th at Eckley No. 10 Colliery, near Hazleton, Pa. There were four men at work in the building at the time, and they had remarkable escapes from death. The men were firing when the first explosion took place. This carried away the rear portion of the boiler-house, and scattered hot coals all about the workmen. They made a hasty exit, but had hardly emerged through the door when another explosion occurred, even more violent than the first. This carried away the remaining portion of the boiler-house and lodged it against the bank supporting the railroad, some distance away. The force with which it struck the bank tore the rails from their fastenings and twisted them so badly that all traffic was suspended for several hours.

(36.) — An iron flange at the "dead end" of one of the main steam pipes in the trolley power-house of the Philadelphia Traction Company, at Thirteenth and Mount

Vernon streets, Philadelphia, Pa., blew off on February 10th, and Michael Welsh, George Gibbs, James Manders, Henry Jones, and George Simpson were injured.

(37.) — On February 8th, a boiler exploded at the Primrose Colliery, operated by C. Nevels & Co., at Mahanoy City, Pa. The exploded boiler was one of a nest of twelve, all of which were disturbed by the explosion. The fireman is said to have had a "premonitory warning" of the coming event. At any rate, he made tracks for a place of safety, and escaped injury.

(38.) — A boiler explosion occurred on February 12th at what is known as the "Q shaft," at Braidwood, near Spring Valley, Ill. A flue collapsed in one of a battery of three boilers, and the boiler-setting and boiler-house were badly damaged. The fireman saw signs of the impending collapse, and his warning enabled those in the boiler-house to get out in time to escape injury. John Harrop, however, who was shoveling slack into the building from a car alongside, failed to hear the fireman's alarm, and he was severely scalded about the back and sides.

(39.) — A switch engine was pulling a train of cars through the Santa Fé yards at Temple, Tex., on February 12th, when its boiler exploded. Engineer Coleman, Fireman Cheatham, Foreman Vogler, and Switchman Hoges were riding on the engine at the time. Coleman was badly scalded and bruised; he will die. Vogler was similarly injured, and will also die. Hoges was blown through the cab window to a distance of 150 feet; he was injured internally, and will die. Cheatham was badly scalded, and his right leg was cut off at the knee; there is no hope of his recovery. The crown sheet of the locomotive was blown through a car, making a complete wreck of it.

(40.) — A boiler exploded on February 13th at Farios Bros.' cork factory, Gibraltar, Ind.

(41.) — The boiler of a large traction engine belonging to W. J. Keeler of Buffalo, N. D., exploded nine miles southwest of that place on February 14th, demolishing the building in which it was used for grinding feed. The engineer was outside at the time, and escaped injury.

(42.) — A boiler exploded on February 15th in B. A. Lockwood & Co.'s elevator, at Kelley, Iowa. John Tanner, the engineer, was blown to pieces, and William Sells was fatally injured.

(43.) — On February 15th a boiler, belonging to James Snyder, exploded at Benton, Ohio. Fred Lehman was hurled against a fence 50 feet away, and fatally injured Snyder's son was also badly injured.

(44.) – John Thompson was fatally injured on February 12th by the explosion of a pumping engine boiler in the Matthews mines, near Cambridge, Ohio.

(45.) — A boiler exploded on February 17th in the new flour mill at Marquette, thirty miles west of Winnipeg, Manitoba. The engine-house was blown to atoms, machinery was hurled in all directions, and one end of the mill was entirely demolished. John Reid, who was running the engine at the time, was instantly killed.

(46.) — A boiler exploded on February 17th in the residence of Herman Burgander on Dana Place, Wilkesbarre, Pa. The damage was slight.

(47.) — A boiler used in the quarry at Squantum, Mass., belonging to the city of Boston, exploded on February 17th. Felix McConn, the engineer, was fearfully burned

and scalded, and another man received lesser injuries. The boiler was blown into the air, and was found nearly a quarter of a mile from its original position.

(48.) — By a slight explosion in the power-house of S. N. Breed & Co., at Lynn, Mass., on February 17th, one man was badly scalded, and a fire was started which did considerable damage.

(49.) — On February 19th, a boiler exploded on the Laurel Farm plantation, near Houma, La. John Clement, Wiltz Rollins, and George McKinner were killed, and a brother of George McKinner was fatally injured. Joseph Martin and two boys named Matthews were also badly scalded.

(50.) — A boiler exploded on February 19th in the basement of a four-story brick building on Sixty-third Street, Chicago. The first floor was shattered by the explosion. The boiler was used for heating purposes.

(51.) — Samuel Johnson, George Washington, William Franklin, Alexander Franklin, and one other man, were killed on February 21st by the explosion of a boiler in the oil mill of Messrs. Freeman & Hayne in Compte, La. Several others were injured The building in which the boiler was located was totally destroyed.

(52.) — On February 21st. Andrew Dahringer was severely injured by the bursting of a boiler at the Hoopes & Townsend Works at Philadelphia, Pa. He was scalded about the face, leg, arms, and chest, and some of his ribs were broken. His condition is critical.

(53.) — A boiler exploded in a grain elevator in Sangamon County, Ill., on February 22d. Two men were badly scalded.

(54.) — Word is received from Dodge Center, Minn., under date of March 1st, saying that "the tow mill started up this week, but the boiler blew out and busted, and work is suspended again." The tow-mill people have our sympathy.

(55.) — During the progress of a fire in a business block owned by the Blythe estate in San Francisco, Cal., on Februrary 26th, a boiler in the basement of the "Golden Rule Bazar" exploded with a loud report, sending the debris in all directions. Fortunately nobody was hurt.

(56.) — The boiler of freight engine No. 1210, on the Baltimore & Ohio Railroad, exploded at Muzam's Mills, W. Va., on February 28th. Engineer Stevenson, Fireman Law, and Brakeman McCue were terribly injured, and later advices state that both Stevenson and Law died from their injuries, and that McCue cannot recover. The train was derailed, the wreck caught fire, and twelve cars were destroyed.

(57.) — Five men were injured on February 28th by the explosion of a boiler in Chidester's mill, near Plum City, not far from Durand, Wis. The injured men will recover. No further particulars have been received.

In a recent lecture on "Photometry," Captain Abney showed, in an ingenious way, the existence of solid particles of carbon in a candle or gas flame. A ray of sunlight was passed through a nicol prism, and focussed on the flame. The path of the beam of sunlight can be readily seen, when the observer looks at right angles to it. The nicol can be so placed, however, that the beam in the flame is invisible; and this proves, by a well-known principle in optics, that there is a multitude of finely-divided *solid particles* in the flame.

Finding of the Areas of Irregular Figures.

We have received the following communication from Mr. Thomas L. Hadley of Woonsocket, concerning the determination of the areas of irregular figures: "I notice that you say in THE LOCOMOTIVE for January, 1890, that 'the most satisfactory way to calculate the area of a segment is that given in THE LOCOMOTIVE for December, 1886. This method is exact, but it requires the engineer or inspector to have the table with him whenever he wishes to calculate a segment.' Here is another method for finding the area of a segment. It is not original with me, however. I believe that the idea came from France, where it was used to find the average pressure of an indicator card. I have applied it also to the determination of the areas of segments and of irregular figures. Suppose, for example, we consider a boiler 66 inches in diameter, in which the upper row of tubes is 26 inches from the top of the shell. Suppose we allow 3 inches out for the flange to support, and 2 inches out for the tubes to support. This leaves a segment 21 inches high, of a circle 60 inches in diameter. To determine the area of this segment, first draw a diagram of the boiler on a scale of one inch to the foot, as shown in Fig. 1. Then find the area of the whole head of the 66-inch boiler. Divide this by 2, which gives the area of half the head. Bisect Fig. 1, as shown by the horizontal diameter, as only half of the diagram is needed to do the problem. Now *cut out* the upper half of the diagram carefully, and weigh it. This piece in the diagram I send you, weighed 12.3 grains. Then *cut out the segment* from this piece, and weigh that also. You will find that the segment weighs 6.35 grains. Then make a proportion as follows:

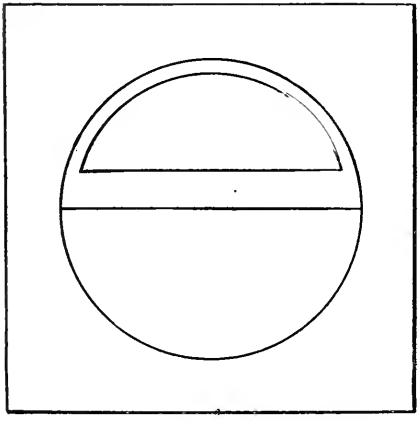
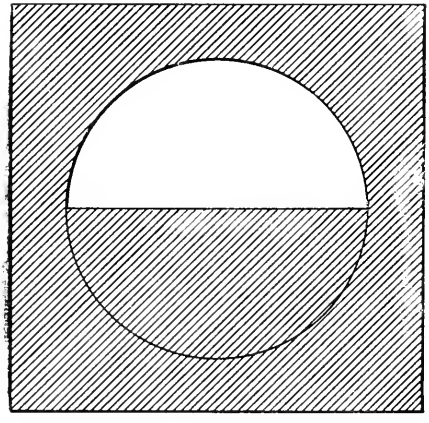
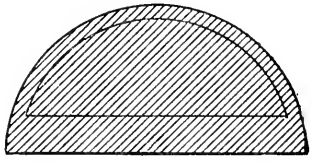


FIG. 1.—AREA OF A SEGMENT.





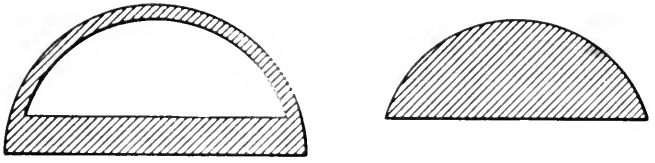
FIGS. 2 AND 3.—AREA OF A SEGMENT.

12.3 : 6.35 :: 1710.6 (area of half the head) : 883.1

From which we conclude that the area of the segment is 883.1 square inches.

"The area and average pressure of an indicator diagram may be found in the same

way. Erect perpendiculars from both ends of the atmospheric line, as in Fig. 6. (Be sure they are square with this line.) Then draw a horizontal line as shown at AC. Next measure the height from A to B by a scale to correspond with the spring used in taking the indicator diagram. This would be the average pressure in the engine, if tak-

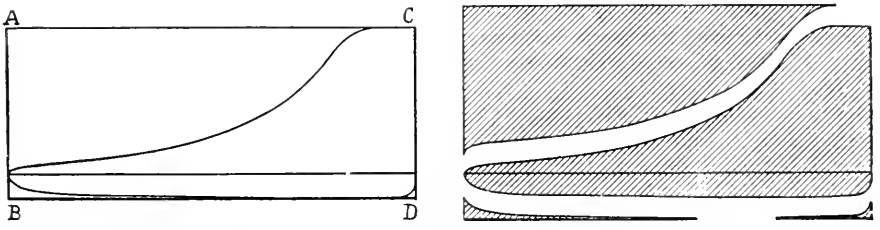


FIGS. 4 AND 5.—AREA OF A SEGMENT.

ing steam full stroke and working theoretically. Cut out the rectangle $ABCD$, and weigh it as before. The result, with the card I send you, was 9.7 grains. Next, cut along the line made by the pencil of the indicator, and weigh the piece so obtained. (I found its weight to be 4.45 grains.) Now the height AB, in this case, was found to be 81 pounds, we have the proportion

$$9.7 : 4.45 :: 81 \text{ lbs.} : 37.2 \text{ lbs.}$$

From which we conclude that the average effective pressure, as shown by the card, was 37.2 lbs. per square inch. To find the area of the card, when we know the average pressure, we first find the average height by dividing the average pressure by the scale of the spring used, which in this case was 40. Thus: $37.2 \div 40 = .93$ in. Then, by



FIGS. 6 AND 7.—INDICATOR CARDS: FINDING AREA AND AVERAGE PRESSURE.

direct measurement, we find the length of the card to be 4.90 inches. Hence the area is $4.90 \times .93 = 4.56$ square inches. (I tested this result by the planimeter, and found it to be correct.)

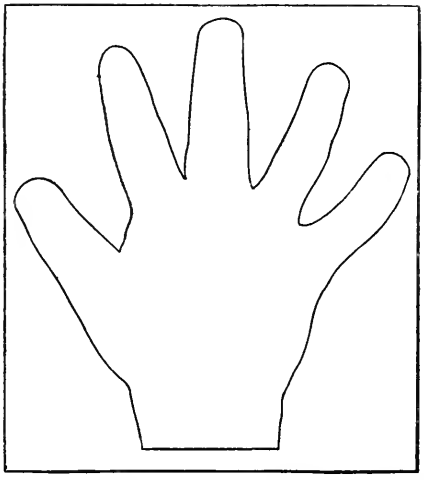
"I send you one more example of the application of the method to an irregular figure, choosing for this purpose the figure given in Fig. 8. The length of the rectangle $ABCD$ is $5\frac{11}{32}$ inches, and its width is $4\frac{17}{32}$ inches; its area, therefore, is 24.21 square inches. Upon cutting out this rectangle, I found it to weigh 23.75 grains. Then, cutting out the part whose area is required, I found it to weigh 11.4 grains. The proportion in this case is

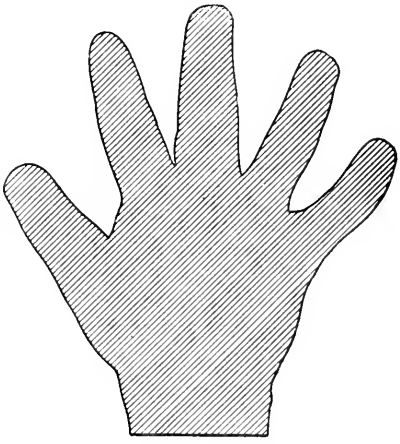
$$23.75 : 11.4 :: 24.21 : 11.62.$$

Hence we conclude that the area of the figure in question is 11.62 square inches. If you consider this method of finding areas to be of any value, you are welcome to use it in THE LOCOMOTIVE."

Mr. Hadley's method, although interesting, is not so new as he imagines it to be.

We do not know with whom it originated, but it was certainly used in Galileo's day. At that time the curve that geometers call the "cycloid" was attracting considerable attention, and many attempts were made to discover a rule for finding the area of cycloids. Galileo was interested in the problem, among others, but he found the mathematical difficulties involved in it to be too great for him to overcome. He therefore drew a cycloid on paper, cut it out, weighed it, and compared the result with the weight of the "generating circle," as cut from a similar piece of paper. We do not remember his precise result, but our impression is that he found the area of the cycloid





FIGS. 8 AND 9.—FINDING THE AREA OF AN IRREGULAR FIGURE.

to be $3\frac{1}{7}$ times the area of the generating circle: the *true* ratio, as has since been shown, being exactly 3. In recent times the method has largely passed out of use, the planimeter being used instead. Mr. Proctor used the "weighing method," however, to determine the proportion of land to water on the surface of the planet Mars. He constructed a special map of Mars for this purpose, and cut out the continents and islands, and compared them with the entire surface by weighing them. The chief objection to the process is its inaccuracy. The weighings must be performed with considerable precision, and this requires the use of a delicate balance, and considerable manipulative skill. Moreover, the paper used for the purpose must be of uniform thickness and density, or the relative weights will not represent the relative areas. This condition is not so easy to fulfill as might be imagined. Drawing paper that has been moistened and stretched on a drawing board so as to make it lie flat, is wholly unsuitable, as may easily be shown by comparing known areas by means of it. In all cases areas to be compared by weighing should be cut from the *same sheet of paper*, and the weighings should be performed as quickly as is consistent with accuracy; for paper is a hygroscopic substance, and the amount of moisture it contains (and consequently its weight) varies with the condition of the air.

IN reply to many inquiries, we beg to say that the Eleventh Census did not include statistics of the steam power in the United States.

The Joule Memorial Statue.

Manchester, England, may well be proud of having been the home of two such famous men of science as John Dalton and James Prescott Joule. A beautiful statue of Dalton, who laid the foundation of the atomic theory in chemistry, has adorned the vestibule of the town hall of that city for some years; and, on December 7, 1893, a statue of Joule was unveiled in the same place, and the two philosophers now stand face to face. The unveiling of the Joule statue was performed by Lord Kelvin (Sir William Thomson), who was peculiarly fitted for that function, both on account of his ability and renown as a scientist, and because he had worked with Joule many years before, when the theory of the conservation of energy was coming out of obscurity and into its present form. The Literary and Philosophical Society of Manchester had the distinguished honor of being really the cradle of Joule's work. From very early days he kept constantly in touch with that society. Many of his most important papers were first given to the world there, and during the last years of his life he was an almost constant attendant at its meetings. Joule's life was remarkably replete with discoveries, but undoubtedly the one for which he will longest be remembered was his "great fundamental discovery" of the mechanical equivalent of heat. "It was not merely by a chance piece of measurement that he stumbled on this result, which was afterwards found to be of great value. It was measurement, rigorous experiment and observation, and philosophic thought all around the field of physical science that made this discovery possible. Very early indeed in his working time Joule brought out the mechanical equivalent of heat, and in a paper read before the British Association at Cork in 1843, and afterwards published in the *Philosophical Magazine*, he gave the famous number '772.' Six years later a second determination gave him the same result, and twenty-five years later he made a third determination, which gave him the final and corrected result, '772.56.'" Lord Kelvin went on to say that he could never forget the meeting of the British Association at Oxford in the year 1847, when, in one of the sections, he heard a paper read by a very unassuming young man, who betrayed no consciousness in his manner that he had a great idea to unfold. He (Lord Kelvin) was greatly impressed by the paper. At first he thought it could not be true, because it was different from Carnot's theory; and, after the meeting, he had a long and thoroughly discursive talk on the subject with Joule, and obtained ideas he had never had before. He afterwards had the great pleasure and satisfaction of making experiments along with Joule, which led to some important results in respect to the theory of thermodynamics. This, he said, was one of the most valuable recollections of his life, and was, indeed, as valuable a recollection as he could conceive in the possession of any man interested in science. Joule's initial work was the very foundation of our knowledge of the steam engine and steam power. Taken along with Carnot's work, it had given the scientific foundation on which all the great improvements since the year 1750 have been worked out, not in a haphazard way, but on a careful, philosophical basis.

After congratulating the city of Manchester on the proceedings of the day, and expressing his emotions at beholding once more the face of his old friend (he pronounced the statue to be "a most admirable likeness"), Lord Kelvin asked to be allowed to congratulate the sculptor also, for the great beauty and the great success of his work. Sir Henry Roscoe, in moving a vote of thanks to Lord Kelvin for his address, mentioned that for thirty years he himself sat at the feet of Joule, whom he might, therefore, claim, in some sense, as his scientific father. Few cities in the world, he said, could boast of two greater men than Dalton and Joule.*

* For the facts presented in this article we are indebted to *Nature*.

The Locomotive.

HARTFORD, APRIL 15, 1894.

J. M. ALLEN, *Editor.* A. D. RISTEEN, *Associate Editor.*

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WE beg to acknowledge the receipt from Mr. Rufus R. Wade, chief of the Massachusetts District Police, of a copy of his *Report* for the year 1893. Mr. Wade says: "I have endeavored to incorporate herein all the information which tends to show what has been accomplished by the District Police during the year covered by this report, which includes not only the prevention of crime and the detection and punishment of criminals, but also the enforcement of the numerous laws relating to the inspection of factories, workshops, and public buildings." This was no small task, as the force of men under Mr. Wade's direction numbers thirty-eight, "of whom twenty-six are detailed for service in the inspection department, eleven designated for detective duty, and one for the inspection of uninsured steam boilers, and to inquire into the ability and competency of the engineers in charge thereof"; but it has been accomplished in a praiseworthy manner.

Navy Department Rules for Bumped Heads.

On page 40 of the *Proceedings* of the forty-first annual meeting of the Board of Supervising Inspectors of Steam Vessels, held in January, 1893, we find the following report of the committee on Boilers and Machinery: "The Committee on Boilers and Machinery having had under consideration the communication of the Supervising Inspector of the Second District, presented to the board by the Supervising Inspector-General on the 31st day of January, 1893, relating to amending the rules to regulate the pressure for 'bumped heads' for marine boilers, beg leave to report as follows: We have carefully considered the proposed amendment and report the same back and recommend its adoption as follows: [To find the] pressure allowed on 'bumped heads,' multiply the thickness of the plate by one-sixth of [the] tensile strength, and divide by the radius to which [the] head is bumped; which will give the pressure per square inch of steam allowed." This report was adopted, and the same rule is repeated, on page 165, among the "General Rules and Regulations." In the *Report* of the proceedings of a special meeting of the Board of Supervising Inspectors, held in May, 1893, however, this rule was amended, on motion of Gen. J. A. Dumont, thus: "*Be it further resolved*, That the rule for bumped heads of boilers adopted at the last meeting of the board, and printed on page 8 of Circular No. 25, 1893, be amended to read as follows: *Pressure allowed on bumped heads.*— Multiply the thickness of the plate by one-sixth of the tensile strength, and divide by six-tenths of the radius to which [the] head is bumped; which will give the pressure per square inch of steam allowed." This latter form of the rule is

also given on page 4 of the *Circular* issued by Gen. Dumont under date of February 19, 1894.

We quote these rules in order to call our readers' attention to them, and prevent, so far as we can, such confusion as might possibly arise from overlooking the early repeal of the first rule.

An Inspector's Strange Experience.

An inspector in our northwestern department writes to us concerning an experience that recently befel him, as follows: "I had an experience a few weeks ago, which I should be quite reluctant to repeat under the same circumstances, if it could be avoided as well as not. I called to make an inspection at a stone works here, where they have two boilers, but use only one at a time. The engineer was working at his two pumps, which he could not get to throw water, and was scolding because he had no steam to run with, although he had had plenty only a short time before. The tubes in the boiler I was going to inspect were badly choked, and in fact nearly filled with soot from the coal. I thought that might be the trouble with the boiler they were using, so I opened the front of that boiler and looked into the tubes. *They were red hot.* I looked for the water. It was gone. I looked under the boiler to see the fire, and *jets of burning gas* were actually spurting out between the rivets on the seams over the fire. And the engineer was still working at his pumps, trying to get some water. I had a queer feeling just at that instant. I got the engineer away from the pumps as soon as possible and had him draw the fire; and I could see the gas burning along the seam while the fire was being drawn. As soon as it was darkened in the arch a little, I could see that the sheet on the bottom of the boiler was red hot for a space about three feet square. As soon as the boiler cooled down we opened the manhole, and found the inside to be bone dry. The outcome was that the seam next to the bridge-wall was badly fire-cracked and sprung, so that a new sheet had to be put in. The tubes all had to come out, and all the seams on the fire surface had to be re-calked; which I consider to be a very fortunate escape."

We have no comment to make upon this report, at present, beyond the statement that the inspector in question is a thoroughly honest and competent man.

We have received from Mr. C. J. H. Woodbury a copy of the *Annual Report* of the School Committee of the City of Lynn, Mass., for the year ending Dec. 31, 1893. It contains much interesting matter, and is a very creditable report. Among other things, we note with pleasure, on page 20, the following reference to the insurance of the boilers of the Lynn public schools in the Hartford Steam Boiler Inspection and Insurance Company: "The insurance of heating boilers in schoolhouses has been an advantage through the efficient service of their corps of inspectors, who have discovered need of repairs in several instances. These experts have also given to the janitors much information upon the best methods of caring for such boilers, and upon economy in fuel. Some changes have been made in the duties of certain janitors in schoolhouses heated by boilers, by relieving them of the care of other schoolhouses, so that they will not leave the boilers during school sessions. The Governor of Massachusetts appointed Mr. Thomas Hawley, a well-known steam engineering expert, to examine into the care and conditions of boilers in schoolhouses and public buildings, and it is a matter of satisfaction that the following portion of the report contained such a commendatory notice of the janitors and boilers in Lynn schoolhouses: 'The method of caring for the boilers

of the schoolhouses in the city of Lynn is a good one. The boilers are all insured in the Hartford Steam Boiler Inspection and Insurance Company, and have the benefit of their regular and efficient inspection. Formerly the practice was to put a janitor in charge of several schoolhouses. The great danger of this practice I have reported to you before, and the proper authorities in Lynn have also realized this danger and some time ago guarded against it, so that now there is no excuse for a janitor to leave his boiler-room while the school is in session, excepting such as the Cobbett School, where two buildings are in the same yard, not a hundred feet apart. It would be possible, of course, for this janitor to spend too much time in one building and not enough in the other if he was so disposed, and such a condition might arise with a negligent janitor in disagreeable weather. The necessity of frequent observation of boilers of the sectional type, such as are used in these buildings, is quite important because of the small amount of water they contain. The general run of janitors in Lynn is above the average in intelligence, and the appearance of the boiler-rooms much more satisfactory. The city has an excellent engineer at the High School. This man was selected by competitive examination, and it is a matter of much importance that from over thirty applicants for the position less than five were at all worthy of consideration because of fitness, showing at once how large a number of men will apply for a position of responsibility, to fill which they have no qualification whatever.'"

The Dangers of the Trolley System.

In a recent issue of the *Standard* we find the following suggestive article by Mr. H. C. Cushing, Jr., on "Unknown Causes of Fires":

When electricity is allowed to roam at large and in vast quantities all along our water and gas pipes and through the ground upon which the city is built, in order to get back to the sources from which it was generated, which are the street railway power stations, it is this state of affairs which is creating a trouble the extent and seriousness of which are only known to those few who have made it a study. These street railway power stations, operating the overhead trolley system, are constantly generating thousands of horse-power of electricity, sending it out by overhead trolley and feed wires to the cars which it operates, and return it to the station by means of the water and gas pipes which lie in its course. For this reason there is a tremendous electrolytic action going on all the time. When I speak of this trouble from electrolysis I do not mean that Boston and Cambridge are the only cities affected, but every city in the United States operating a trolley system with ground returns. The writer has samples of gas and water pipe completely eaten through by electrolytic action in three months after having been placed in the ground near street railway returns. This effect has been going on and will continue to go on as long as there is a grounded wire in electric street railway construction.

Whenever this returning current flows in any quantity along a pipe there is bound to be a large fall of potential, varying in different pipes as their carrying capacity increases or diminishes.

In the cellars and basements of many houses I have found quite a large difference of electrical pressure between two pipes entering within one foot of each other, and in one instance it was a very easy matter to take a piece of hoop iron and draw an electric arc sufficient to ignite a piece of waste held near it, and by connecting these pipes together with a piece of No. 18 copper wire, the current flowing through it was

sufficient to heat it so that it was impossible to lay one's hand upon it. In the basement of another building, not 200 yards from where the writer sits, I find a man using twenty-five amperes at eight volts pressure, or electricity enough to run small motors and incandescent lamps, as well as all the electrical bells in the entire building, by simply twisting his wires around two different water pipes which enter the building.

Some time ago my attention was called to two pipes which were so close together that the vibration of an elevator engine caused them to knock together just sufficient to create an arc every time a contact was made and broken. This had been going on so long that it had almost completely eaten through the gas pipe, and it is perfectly evident what would have taken place had this been allowed to go on unobserved. The gas would have been ignited, as soon as the first small hole appeared, by the electric spark, and disastrous results would have undoubtedly followed. This difference of electrical pressure upon water and gas pipes is now so well known that in a number of cases in the cities of Boston and Cambridge, the ordinary electric bell battery is entirely discarded and the wires from the bells connected directly to the water pipes, the latter furnishing an inexhaustible supply of electricity at the proper pressure to run any number of bells or gas-lighting apparatus, and also to do any quantity of mischief. I can see no reason why fires should not be attributed to this cause, when it can be proved that such a difference of electrical pressure really does exist between any two pipes entering a building in the vicinity of the trolley system of street railways.

There is only one way of eliminating this rapidly increasing danger, and that is by compelling the electric street railway companies to insulate, from the ground, their entire electric circuit, and just as soon as a suit for damages is brought by the water and gas companies for a complete system of pipes destroyed by electrolysis, the railway companies will begin to remedy the evil, which they are more fully aware of than any one else.

The Progress of the Telephone.

In a recent issue of the *Scientific American* we find an interesting address upon this subject, which was delivered by ex-Governor Long before the Committee on Mercantile Affairs of the Massachusetts legislature, when the American Bell Telephone Company asked the privilege of increasing its capital from $20,000,000 to $50,000,000. This company was incorporated in 1880, with a capital of $10,000,000; and in 1889 the legislature allowed it to increase its capital to $20,000,000, at which figure it now stands. Up to the first day of January, 1885, the company had expended $31,000,000 for materials and for labor. Since that date it has expended $12,349,000 in overhead equipment, over $10,000,000 for subways or underground conduits, and over $4,000,000 for cables. It has erected a million-dollar fire-proof building in Boston and other buildings in New York and other cities. In the one item of real estate it has expended $5,884,400 since January 1, 1885. Mr. Long stated, in speaking of the long distance systems, that the line from New York to Chicago is 1,200 miles long, or 2,400 miles for the complete "metallic circuit." This wire is of copper, one-sixth of an inch in diameter, weighing 435 pounds to the mile; and the total weight of the copper in the circuit is 1,044,000 pounds. In this and other long distance lines the company has expended $10,000,000. "Stand in New York city," said Mr. Long, "and you can talk with a man in Boston to the east, in Chicago or Milwaukee to the west, in Buffalo to the north, in Washington to the south. In other words, you are covering by the sound of your voice an area which contains half the people of the United States." At the beginning of

1881, the year after the first charter was granted, the number of miles of wire in use for telephonic purposes was 29,714; on January 1, 1894, it was 488,521, or twenty times the circumference of the earth. The putting of wires underground was begun about 1885. On January 1st of that year there were 1,225 miles of wire underground; and on January 1, 1894, there were 115,000 miles of it there. On the first day of the present year there were 566,491 telephones in use. In 1881, there were 47,800 subscribers; to-day there are 237,000. In 1884 there were 215,000,000 "talks" over the telephone; in 1893 there were 600,000,000. (The average number of *telegraphic* messages per year was stated by Mr. Long to be about 63,000,000.) The average expense to a subscriber for a single message is said to have been somewhere between 2 and 11 cents. The company employs over 10,000 persons. The largest switchboard is the one in New York city, which is 264 feet long, and represents 10,000 subscribers. The stock of the company consists of 200,000 shares. There are 5,277 stockholders, and of these stockholders, 3,721 (or nearly three-quarters of them) have holding of less than 25 shares each. The company pays into the treasury of the State of Massachusetts, annually, $150,000 in taxes.

These figures give a very good idea of the magnitude of the telephone interest in this country.

They Formed a Short Circuit.

The biggest snake story this spring was brought in to-day by Uriah Belden, who lives over in Devil's Hop Yard, near East Lyme, Conn. He says that a few days ago, while on a hunting tour in a patch of woods near Comstock's Bridge, north of here, he came upon a wheelbarrow load of large black snakes tied up in hard knots and stone dead. In the brush about the place he discovered twenty-five or thirty smaller black snakes, none of which was over eighteen inches long, many of which he killed. A couple of telegraph wires ran through the woods overhead, and Belden, who was much mystified by the tragedy of the snakes, soon after met a lineman, who gave him an interesting theory as to the probable solution of the deaths of the older serpents. There had been a heavy blast set off in a quarry near by a few days before, the lineman said, which broke down the telegraph wires and started a colony of black snakes from their winter slumber in a neighboring ledge. One of the wires, it appears, was "crossed" in a distant city by a deadly trolley wire, and hence the broken wires as they lay in a cart path near the snake's den, the ends not more than two feet apart, constituted a death trap. Any moist, living object touching the end of both wires at the same time would "short circuit" them, carrying the electric current from the "crossed" wire to the other, and incidentally sustaining a shock fatal to life. The lineman calculated that the snakes started up the cart path toward a brook after being disturbed by the blast and, as they came to the wires trailing on the ground, one after another crossed over and "short circuited" them, sustaining an instantaneous shock which caused death at once. Had it been possible for a snake's body to have still connected the wires after death, the lives of many of the snakes might have been spared, but immediately upon being shocked the snake curled up in a hard knot, thus opening the circuit and setting the trap again. The reason why the smaller snakes were not killed by the current was because their bodies were not quite long enough to reach from one wire to the other and complete the deadly "short circuit." Mr. Belden says he regards the lineman's idea as the correct one. He counted eleven of the snakes which were killed by the lightning. They were from three to eight feet long.— *New York Sun.*

The Engineer's Concert.

"I was loitering around the streets last night," said Jim Nelson, one of the old locomotive engineers running into New Orleans. "As I had nothing to do, I dropped into a concert and heard a sleek-looking Frenchman play a piano in a way that made me feel all over in spots. As soon as he sat down on the stool I knew by the way he handled himself that he understood the machine he was running. He tapped the keys way up one end, just as if they were gauges, and he wanted to see if he had water enough. Then he looked up as if he wanted to know how much steam he was carrying, and the next moment he pulled open the throttle and sailed on to the main line as if he was half an hour late. You could hear her thunder over culverts and bridges, and getting faster and faster, until the fellow rocked about in his seat like a cradle. Somehow I thought it was old '36' pulling a passenger train, and getting out of the way of a 'special.' The fellow worked the keys on the middle division like lightning, and then he flew along the north end of the line until the drivers went around like a buzz saw, and I got excited. About the time I was fixing to tell him to cut her off a little he kicked the dampers under the machine wide open, pulled the throttle way back in the tender, and how he did run! I couldn't stand it any longer and yelled to him that he was pounding on the left side, and if he wasn't careful he'd drop his ashpan. But he didn't hear. No one heard me. Everything was flying and whizzing. Telegraph poles on the side of the track looked like a row of cornstalks, the trees appeared to be a mud bank, and all the time the exhaust of the old machine sounded like the hum of a bumblebee. I tried to yell out, but my tongue wouldn't move. He went around curves like a bullet, slipped an eccentric, blew out his soft plug, went down grades fifty feet to the mile, and not a controlling brake set. She went by the meeting point at a mile and a half a minute, and calling for more steam. My hair stood up straight, because I knew the game was up. Sure enough, dead ahead of us was the headlight of a 'special.' In a daze I heard the crash as they struck, and I saw cars shivered into atoms, people smashed and mangled and bleeding and gasping for water. I heard another crash as the French professor struck the deep keys away down on the lower end of the southern division, and then I came to my senses. There he was at a dead standstill, with the door of the fire box of the machine open, wiping the perspiration off his face and bowing to the people before him. If I live to be 1,000 years old I'll never forget the ride that Frenchman gave me on a piano.—*N. O. Times-Democrat.*

A CORRESPONDENT criticises a statement recently made in this paper, to the effect that in tables of the properties of steam it is often assumed that the pressure of the atmosphere is an even 15 pounds per square inch. We are pleased to be criticised in a friendly spirit; but this fellow, having discovered a mole-hill which he fondly imagines to be a mountain, waxes insolent, and accuses us of divers things that he ought to know are not so. The focus of his letter seems to be the grandiloquent challenge to us, to produce one single, solitary instance of such a table as we referred to. We should be sorry not to satisfy him to this small extent, especially as we judge from his letter that his reading in steam engineering has not been very extensive. We refer him, therefore, to Edwards's *American Steam Engineer*, to Barr's *Steam Boilers*, and to Nystrom's *Steam Engineering*. We could refer him to others if it were worth while. (Nystrom, in the first two lines of his table, distinguishes between 14.7 and 15.0 lbs., but in the rest of the table he makes no such distinction.)

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The Locomotive.

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The Chilling Action of Feed Water.

We have repeatedly called attention to the importance of locating feed-pipes correctly, and to the strains that are produced in boilers by the discharge of feed water in places where it will chill the shell. The contraction of iron from such a cause is practically irresistible, and the result is that joints are strained and boilers are badly damaged, simply because the importance of having the feed-pipe properly located is not understood.

A short time ago an excellent illustration of feed-pipe troubles came under our

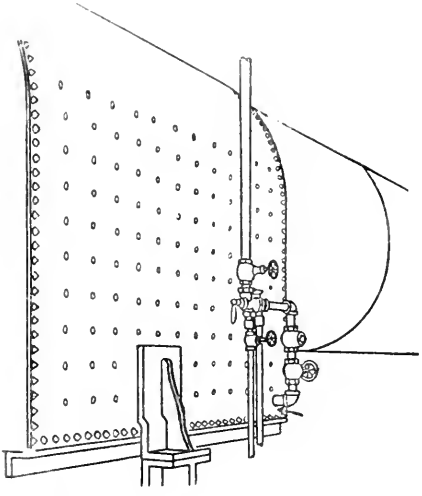

FIG. 1.—SHOWING THE LOCATION OF THE FEED PIPE.

observation, and, thinking the matter might interest readers of THE LOCOMOTIVE, we made some experiments with this boiler, both before and after changing the feed-pipe. The boiler in question is of the locomotive type, 24′ 3″ long, and with a 66-inch barrel. It is made of steel throughout, the plates being $\frac{3}{8}$″ thick, and the heads $\frac{7}{16}$″ thick. There are 114 tubes, 16 feet long and three inches in diameter; and on the barrel there is a 30-inch dome, 36 inches high. The longitudinal joints are double-riveted, with $\frac{3}{4}$-inch rivets, and a pitch of $3\frac{1}{4}$ inches. The furnace is 72″ long, 66″ wide, and 60″ high. The stay-bolts, $\frac{7}{8}$″ in diameter, are pitched $5\frac{1}{2}$″ from center to center. The boiler has been in position only a short time, and has not yet been covered. It is supported, at the back end, on a cast-iron chair.

When the boiler was put in use, it was found that the girth joint, near the middle

of the barrel, sometimes leaked. It was thought, by the engineer in charge, that this might be due to distress from the weight of the boiler and contents, and to relieve this distress he put another cast-iron chair under the middle of the barrel, near the troublesome girth joint. It was thought that this chair would sustain its share of the boiler's weight, and that the trouble would disappear. Such was not the case. The boiler behaved as badly as ever; and it was observed that when the joint leaked, the boiler was elevated at the middle of its length — "hogged up," as the saying is, — so that it did not rest on the middle saddle. At this point we were called upon to diagnose the case and suggest a course of treatment. The results of the diagnosis, and the success attending the application of the remedy we proposed, are given below, in the present article.

Having had a considerable experience with cases of this kind, we were at once led to

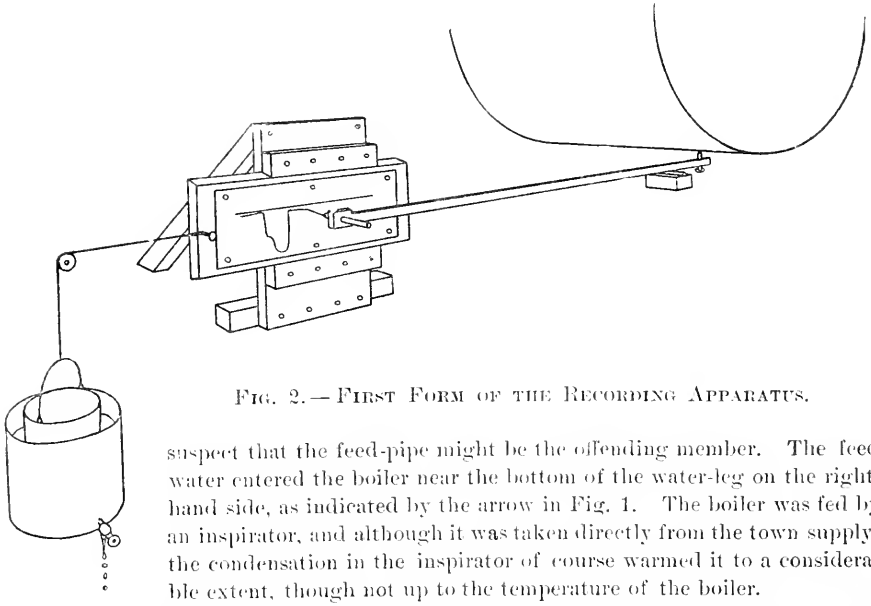

FIG. 2. — FIRST FORM OF THE RECORDING APPARATUS.

suspect that the feed-pipe might be the offending member. The feed water entered the boiler near the bottom of the water-leg on the right-hand side, as indicated by the arrow in Fig. 1. The boiler was fed by an inspirator, and although it was taken directly from the town supply, the condensation in the inspirator of course warmed it to a considerable extent, though not up to the temperature of the boiler.

Before proceeding to a description of the experiments, it will be well to state what we believed the cause of the trouble to be. The boiler was used for pumping water out of a quarry, and it frequently lay idle for a considerable time, with steam on, and ready for work at a moment's notice. When the boiler was doing no work, the damper being shut, and the fire-doors open, the circulation would naturally slacken, and after a while the water would become practically quiescent. Then if the inspirator were started, the comparatively cool feed water, heavier than that in the boiler on account of its lower temperature, would perhaps first displace the water in the lower part of the water-leg, and would then flow back along the bottom of the barrel of the boiler, chilling it and causing it to contract both longitudinally and girthwise. The contraction so produced would cause the bottom of the boiler to raise up, and this would lift it free of the middle saddle, at the same time straining the girth joint so as to make it leak. If the pump in the quarry were *running* at the time of feeding, there would probably be a good circulation in the boiler, and the cooler feed water would immediately mix with

the circulation currents, and we should expect to find the leakage much smaller in amount than before, or perhaps not noticeable at all.

To test this theory (which our general experience had long indicated to be correct), we devised the apparatus shown in Fig. 2. It consists of a board with beveled edges, arranged so as to slide freely between guides screwed to an upright back-board. To the sliding board a piece of drawing paper was secured, against which rested a pencil attached to a lever in the manner shown. The other end of the lever was in contact with the bottom of the boiler, near the point at which the girth joint passed under it; and the knife-edge fulcrum was so placed that the movements of the boiler were magnified by the lever eight times, — an elevation of the boiler-shell of $\frac{1}{8}$ of an inch, causing the pencil to move precisely one inch. To draw the movable board along at a uniform rate, a pail containing sand was floated in a large bucket of water, and the water was allowed to flow slowly out of the bucket by means of a pet-cock. As the water level went down, the pail containing the sand followed it, and the board was drawn along so that the pencil drew an irregular line, representing the motion of the boiler.

It is difficult to adjust a small water-jet so that it shall have a uniform discharge, and for this reason the working of the apparatus was not so good as could be desired. However, the diagram shown in Fig. 3 was obtained by means of it, the times being

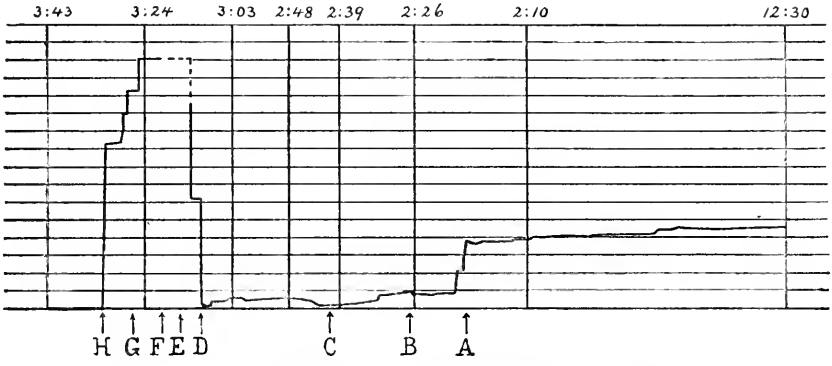

FIG. 3. — FIRST DIAGRAM OF THE MOVEMENTS OF THE BOILER.

recorded by marking the position of the pencil at frequent intervals. The lowest of the horizontal lines in Fig. 3 is the line drawn by the pencil by moving the board by hand, at a time when the boiler was down on the middle saddle (and therefore at its lowest point). The spaces between the equidistant horizonal lines each represent a motion of the boiler of one-fiftieth of an inch. The test was begun at 12:30 P. M., at which time, it will be seen, the boiler was $4\frac{1}{2}$-fiftieths of an inch (or .09″) above its normal horizontal position. The quarry pump was not running, and the boiler was lying idle and doing no work whatever. Nothing was done for nearly two hours, during which time, it will be seen, the boiler scarcely moved. At 2:20 (marked *A* in the diagram) the quarry pump was started, and of course the water in the boiler was thereby put in circulation. This caused an equalization of temperature all over the shell, and it will be seen that the boiler came down immediately, until it was within a fiftieth of an inch of the normal position. With the quarry pump still running, and the circulation brisk, the inspirator was started at 2:27 (see *B*). As anticipated, there was no observable effect, and the inspirator was stopped again at 2:41 (see *C*). All this time the quarry pump was run-

ning, and it continued to run until 3:04. During all this time there had been no sign of leakage from the girth-joint, except the slightest trace of vapor, which had been occasionally visible between 12:30 and 2:20, when the air in the boiler-room was still. At 3:04 the quarry pump was stopped, and after waiting just one minute for the circulation to subside a little, the inspirator was started (see *D*). The boiler promptly rose until it was at least .28″ above the normal position. (The pencil, unfortunately, ceased to mark for a short time, and the dotted part of the record is conjectural.) The girth-joint plainly showed distress, and at 3:13 (see *E*) it was leaking water quite freely. At 3:19 (see *F*) the inspirator was shut off, but still the leak continued, and the boiler maintained its abnormal position. At about 3:27 (see *G*) the quarry pump was started again, and the resulting circulation speedily equalized the temperature in the boiler so that at 3:33 (see *H*) the boiler was resting on the middle saddle, and the leakage had entirely disappeared. The quarry pump continued running, and at 3:43, when the test was discontinued, the boiler was still in its normal position.

It was thought that the diagram we have described would suffice to demonstrate that the chilling action of the feed-water was responsible for the trouble that the owners of this boiler experienced, but as it was found impracticable to regulate the flow of water from the bucket satisfactorily, the apparatus was modified to some extent, and the experiments were repeated. The modification consisted in the substitution of a clock for the water bucket, as shown in Fig. 4. The face and hands of the clock were removed, and a carefully-turned hardwood pulley, 1¾″ in diameter, was secured to the hour spindle. The cord from the movable board was passed completely around this pulley, and to the end of the cord a weight was attached, which was found by experiment to be almost sufficient to overcome the friction of the board.

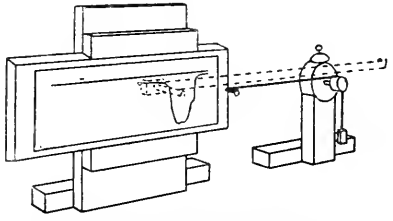

FIG. 4.—IMPROVED FORM OF THE RECORDING APPARATUS.

With the modified apparatus a new test was made, substantially as before. Marks were made on the moving board, at known intervals of time, for the purpose of testing the regularity of its motion, and it was found that in the improved form of the apparatus the motion of the board could be considered, without sensible error, to be absolutely uniform. The test was begun at 10:22½ A. M., at which time the quarry pump was running. At 10:23 the inspirator was started, with the pump still running, and for nine minutes there was no noticeable effect. The water level was purposely carried very high, and at 10:32 the boiler began to rise from the saddle, the circulation apparently being insufficient to take care of the large body of feed that was introduced. The inspirator was stopped at 10:34, but the boiler continued to rise until about 10:36. The girth seam began to leak water about 10:32, and at 10:38, four minutes after the inspirator was stopped, the circulation seemed to succeed in equalizing the temperature again, for the boiler went down promptly until it rested on the saddle, and the leak disappeared. From this time until 10:57 the boiler did not leave the saddle by more than the hundredth part of an inch. At 10:57 the quarry pump, which had been running ever since the experiment began, was stopped, and the boiler began to rise very slowly, and it was a trifle more than .04″ above the saddle at 11:28. It is not easy to say what was the cause of this slight variation, but as the boiler was uncovered, and the cool, out-door air blew against the bottom of it through a window, it is possible that the chill so produced was sufficient to cause the observed rise. At 11:28 the inspirator was started, and the

boiler, reversing the usual proceedings, immediately went *down* about .02". After the inspirator had been running about six minutes the boiler suddenly began to rise again, and the girth joint began to leak steam. At 11:39, with the inspirator still running, the quarry pump was started, and the increased circulation brought the boiler down on the saddle with great promptness. The inspirator was stopped at 11:43, and the experiment was brought to an end at 11:50.

After the experiments described above were completed, the feed-pipe was re-arranged. The opening through which it entered the water-leg (see Fig. 1) was plugged up, and the feed was led to the top of the barrel of the boiler and was passed downward

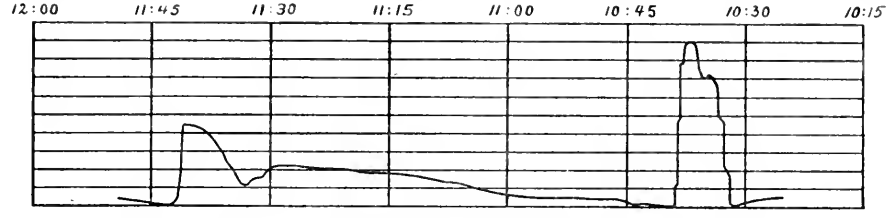

FIG. 5.—SECOND DIAGRAM OF THE MOVEMENTS OF THE BOILER.

through the shell at a point on the furnace side of the dome. After passing down nearly to the level of the tubes, the feed-pipe was run horizontally along the tubes for a distance of 13 feet, which brought it within three feet of the back head. At this point a tee was secured to it, and branch pipes to the right and left were screwed into the tee, so that the discharge would take place at the sides of the barrel. It was believed that the feed water, running through this considerable length of internal pipe, would be heated nearly to the temperature of the boiler before it was discharged, so that its chilling action would no longer be appreciable; and subsequent experiment showed this to be the case. (We always recommend the use of an internal feed-pipe. Those inter-

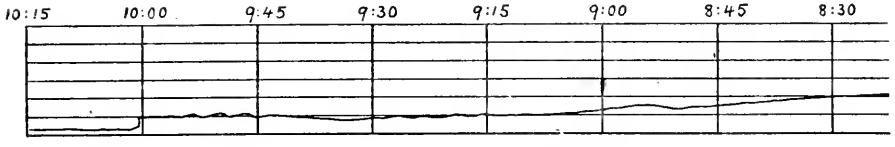

FIG. 6.—THIRD DIAGRAM. TAKEN AFTER CHANGING THE FEED PIPE.

ested in the arrangement recommended for the ordinary horizontal tubular boiler will find it described in the issues of THE LOCOMOTIVE for May, 1883, and January, 1893.)

After the feed-pipe had been changed, another diagram was taken from the boiler, with the result shown in Fig. 6. (The diagrams are all on the same vertical scale, and in each case the space between any two adjacent parallel horizontal lines represents a motion of the boiler of $\frac{1}{50}$th of an inch.) The experiment was begun at 8:21 A. M., with the quarry pump running slowly. There was no leak visible, and the boiler was within about .04" of the saddle. With the pump still running slowly, the inspirator was started at 8:50. At 8:58 the pump was set at work at full speed, and the inspirator was stopped again at 9:11. At 9:32 the quarry pump was stopped also, and after allowing nine minutes for the circulation to subside, the inspirator was started once more (with

the boiler idle) at 9:41. The inspirator was stopped at 10:00, and at 10:01 the quarry pump was started. The experiment came to an end at 10:14, as it was considered that the efficacy of the remedy we had proposed was abundantly proved. Instead of the violent changes observed in the earlier diagrams we had obtained a fairly uniform line, and the entire range of the motion of the boiler was less than .04". No leakage was observed, and neither the inspirator nor the quarry pump had the least observable effect on the boiler, except for the slight fall towards the normal position observed when the pump was started at 10:01 ; and even then the motion amounted to only about .01".

Throughout these experiments records were kept of the steam pressure, of the times of firing, and of the position of the damper. There was evidently no connection whatever between any of these things and the motion of the boiler, so they have not been enumerated in the present article. The pop-valve on the boiler was set at 100 lbs., and during the course of the experiments it blew off once. This was at 9:15, on the third day (Fig. 6). It blew for only about thirty seconds, and evidently did not disturb either the boiler or the apparatus.

The effect of cold feed water on shell-plates and girth joints is discussed, in accordance with theoretical principles, in THE LOCOMOTIVE for March, 1893.

Inspectors' Report.

MARCH, 1894.

During this month our inspectors made 7,915 inspection trips, visited 16,700 boilers, inspected 6,512 both internally and externally, and subjected 527 to hydrostatic pressure. The whole number of defects reported reached 11,324, of which 1,181 were considered dangerous; 63 boilers were regarded unsafe for further use. Our usual summary is given below:

Nature of Defects.	Whole Number.	Dangerous.
Cases of deposit of sediment,	914	64
Cases of incrustation and scale,	1,965	78
Cases of internal grooving,	93	15
Cases of internal corrosion,	522	36
Cases of external corrosion,	789	56
Broken and loose braces and stays,	187	53
Settings defective,	350	42
Furnaces out of shape,	428	29
Fractured plates,	317	57
Burned plates,	324	26
Blistered plates,	295	16
Cases of defective riveting,	1,188	14
Defective heads,	93	22
Serious leakage around tube ends,	2,045	407
Serious leakage at seams,	489	31
Defective water-gauges,	294	54
Defective blow-offs,	201	38
Cases of deficiency of water,	14	10
Safety-valves overloaded,	72	31
Safety-valves defective in construction,	90	24
Pressure gauges defective,	527	42
Boilers without pressure gauges,	29	29
Unclassified defects,	99	7
Total,	11,324	1,181

Boiler Explosions.

MARCH, 1894.

(58.)—A boiler exploded, on March 1st, at Freely's Mills, in Elroy township, near Warsaw, Ind. Engineer Frank Ripley was blown seventy yards away, and instantly killed. Superintendent Charles Dawson was pinned down by falling timbers, and before he could be rescued he was scalded to death. Fireman William Webb was also fatally scalded. John Freely, one of the proprietors, was struck by a flying fragment of the boiler. Both of his legs were broken, and he will die. Several other men were badly scalded and otherwise injured. Two buildings were wrecked, and a fire which followed the explosion did much damage.

(59.)—Two men were killed, and another was severely injured, by the explosion of a boiler at Gulf, Chatham county, N. C., on March 1st. The mill in which the boiler stood was completely wrecked, and parts of the boiler were found 300 yards away.

(60.)—A large boiler in Renshaw's livery stable, at Plymouth, near Wilkesbarre, Pa., exploded on March 3d. The dome of the boiler blew off, and went up through the building, to the roof. It passed within two feet of a bed on which Marvin Renshaw, a son of the proprietor, was sleeping. The bed was blown against the ceiling, and Mr. Renshaw received slight injuries. John Morgan, who was in the boiler room at the time of the explosion, was seriously scalded. The building was set afire, but the flames were soon controlled.

(61.)—A boiler exploded, on March 6th, in Hammond Bros.' mill, at Rock Elm, near Ellsworth, Wis. Considerable damage was done to the property. Otis Lehman's leg was broken, and Joseph Weix and Charles McKernon were badly scalded. It is said that the fire-box of the boiler was defective.

(62.)—A boiler exploded in the McDonald oil fields on March 6th. It was located at the Forest Oil Company's No. 4 Dixon well, back of Willow Grove, near Pittsburgh, Pa. Edward Neely, who was in the boiler shed at the time, was blown high in the air, and instantly killed.

(63.)—A boiler belonging to Mr. T. M. Douglass, of Plain City, Ohio, exploded on March 7th. Mr. Douglass, who was his own engineer, was badly scalded.

(64.)—On March 7th a boiler belonging to Mr. George Kelly exploded at Ridgeway, Ill. Engineer Charles Caldwell and five other men were badly injured, and some of them will probably die.

(65.)—The boiler of locomotive No. 468, of the Lehigh Valley railroad, exploded on March 8th, at Tannery Siding, near White Haven, Pa. John Lenox, Arthur Dotter, and Edward Fox, who were on the locomotive at the time, were instantly killed, and engineer Patrick Dugan, who was in the telegraph office, was knocked down and bruised. The locomotive was completely wrecked, and the track and embankment were badly torn up.

(66.)—An upright boiler in the machine shop of Fahey & Fowler, Pittsburgh, Pa., exploded on March 9th, killing Otto Kelleher and seriously injuring Frank Fowler. Mr. Fowler received an ugly scalp wound, a compound fracture of the lower jaw, and severe burns about the arms and legs. It is known that Fowler was hauling the fire at the time of the explosion.

(67.) — On March 14th a boiler exploded at Vale's mill, in Sombra Township, near Dresden, Ont. The mill had just shut down for the noon hour. Engineer Adam Cornell and his three children, who were in the boiler room, were killed. The building was entirely demolished. Mr. Cornell's children had just brought him his dinner. The two little girls were hurled in opposite directions, and were found 100 yards from the scene of the explosion. The boiler passed directly over a neighboring house.

(68.) — On March 13th, while Mr. James A. Frazier and Mr. A. E. White were on the little locomotive that runs from Goshen, Va., to the Victoria mines, the boiler of the locomotive burst. The engineer was seriously scalded, and Mr. Frazier's face and hands were badly cut. Mr. White escaped without injury.

(69.) — A boiler used in drilling oil wells on the Warren-Barber farm, just east of Mendon, near Celina, Ohio, exploded on March 13th, with terrific force, but fortunately nobody was injured. The men were at work on the derrick, two hundred feet from the boiler. A large piece of the boiler was blown half a mile into the woods, where it cut down a tree.

(70.) — A boiler exploded at the Knowles, Taylor & Anderson sewer pipe works, in East Liverpool, Ohio, on March 15th. Engineer William Anderson, and William Gilkinson and George Anderson, were severely burned about the face and hands. The boiler room was almost demolished.

(71.) — Peter Guldenbronson, Charles Moore, Mary Evans, and Harriet Brown were injured in a boiler explosion at the Elite laundry on West Madison street, Chicago, on March 17th. Guldenbronson is a machinist, and was at work in the engine room. Over twenty men and women were at work in the laundry at the time. The boiler was shattered into a hundred pieces, one of which struck Guldenbronson, breaking his jaw and bruising him badly.

(72.) — On March 19th a boiler exploded in W. M. Bertley's mill, on East Second street, Los Angeles, Cal. The boiler was hurled through the roof of the mill, and landed about 100 feet away. Fortunately nobody was hurt.

(73.) — A boiler at the Syracuse coal shaft, near Pomeroy, Ohio, exploded on March 20th, badly burning the engineer, G. W. Nease.

(74.) — A boiler in the machine shop of Swanson Bros. & Meeter, at Hawarden, Iowa, exploded on March 23d, and two men, Levi Gleason and Frank Swanson, were badly scalded and bruised by the flying débris. The boiler went through the west side of the shop and crashed into J. T. Van Orman's stable, making a complete wreck of the office. Gleason's legs were badly scalded and his face was burned and bruised. Swanson was not quite so badly injured, though his left side was severely burned.

(75.) — On March 24th a boiler exploded in the Haeger brick and tile factory, at Gilberts, near Elgin, Ill. The entire plant was demolished, and the fire that ensued nearly destroyed the town. August Tarnow, a fireman, was in the boiler room when the explosion occurred. He was killed, and his body was buried in the débris. Adjoining the exploded boiler was another one of similar size, which had not been used for some time. The explosion blew the idle boiler from its setting, and through a brick wall. It landed outside of the building. The total loss was estimated at $50,000.

(76.) — The pump-boat *Hero*, belonging to Armstrong Bros., of Point Pleasant, W. Va., burst her boiler on March 28th, killing the engineer, John McGuffin, and injuring several others. The United States Inspectors were on board the *Annie L.* (which

was lying alongside the *Hero*) at the time, and one of them, Mr. Ira Huntington of Gallipolis, was quite severely scalded. They would all have been killed had they not been in the engine room of the *Annie L.* The *Hero* was totally wrecked, and sank in two minutes. One side of the *Annie L.* was also badly damaged. The body of engineer McGuffin could not be found.

(77.) —A boiler exploded on March 31st in A. W. Marshall's foundry, at Hickory, near Statesville, N. C. Mr. Marshall was cut in several places, and his engineer was scalded on the hands and legs.

The Causes of Fires.

The *Chronicle*, a weekly insurance paper published in New York city, has recently issued an extra number in which the causes of fires have been exhibited graphically for different classes of property. The classification is very complete, as it embraces no less than 129 heads, beginning with "Agricultural Implement Factories," and ending with "Worsted and Yarn Mills." The diagrams are based on statistics prepared for the *Chronicle Fire Tables*, and in making them up tens of thousands of fire reports have been examined in the more common risks, and in only a very few cases (in classes of risks in which fires are not frequent) has the number of fires examined been less than one hundred. In commenting on the diagrams and illustrating their usefulness, the *Chronicle* says: "In agricultural implement factories it is plain that the inspector should give his first attention to the dirt and rubbish where spontaneous ignitions may happen; he should be almost equally alert to discover to what extent the risk is protected against sparks. Almost one-half of the inherent hazard in asylums is in defects in flues. In bakeries and confectioneries, defective ovens, grease, flues, stoves, and matches are responsible for nearly two-thirds of the fires. In blacksmith shops, as one would expect, the greatest danger is from sparks. In brick and tile works, overheated and defective kilns, and sparks and engines, cause three-fourths of the fires. In breweries, sparks, dust explosions, friction in machinery, ignition of tar, and spontaneous combustion cause nearly fifty per cent. of the fires. In candy factories, chimneys, furnaces, stoves, and gas jets are the things to look after. In carriage and wagon factories, spontaneous combustion, sparks, defective flues, and stoves are the chief sources of danger. In clothing factories, stoves, matches, ashes, lamp explosions, and furnaces are more dangerous than a host of minor causes. In cotton goods factories, friction in machinery causes nearly two-thirds of the fires. Locomotive sparks cause most of the fires in cotton in transit. In dry goods stores, gas jets, lamps, and matches are the principal hazards. In dwellings, defective flues, matches, and lamp explosions cause one-half of all the fires. In electric light stations, electric wires, lightning, and engines and boilers cause more fires than all other sources combined. In grain elevators, locomotive sparks, friction in machinery, and spontaneous combustion are the underwriters' enemies. In greenhouses and floral establishments, furnaces and defective flues are far in the lead. In hotels, defective flues, stoves, and explosions of lamps are the chief fire causes. In livery stables, cigar stubs, lamp explosions, matches, and defective flues produce about as many fires as all other hazards combined. In schoolhouses, defective flues and the heating apparatus are the principal fire causes. In theaters, the devices for lighting cause one-third of all the fires. And so on, throughout the list."

These diagrams should be of exceeding value to insurance men, for they are very complete, and they tell their story at a glance.

The Locomotive.

HARTFORD, MAY 15, 1894.

J. M. ALLEN, *Editor.* A. D. RISTEEN, *Associate Editor.*

THE LOCOMOTIVE *can be obtained free by calling at any of the company's agencies.*

Subscription price 50 cents per year when mailed from this office.

Bound volumes one dollar each. (*Any volume can be supplied.*)

Papers that borrow cuts from us will do us a favor if they will mark them plainly in returning, so that we may give proper credit on our books.

WE have received the *Report* of the Badische Gesellschaft zur Ueberwachung von Dampfkesseln (of Mannheim), the *Report* of the Norddeutscher Verein zur Ueberwachung von Dampfkesseln (of Hamburg), the *Report* of the Märkischer Verein zur Prüfung und Ueberwachung von Dampfkesseln (of Frankfurt), and the *Report* of the Schlesischer Verein zur Ueberwachung von Dampfkesseln (of Breslau); and we desire to express our thanks for them to the respective associations.

WE desire to acknowledge a copy of *Notes on Steam Boilers*, by Professors C. H. Peabody and E. F. Miller. This book, as we understand it, is not published for general circulation, but for the use of the students in the Massachusetts Institute of Technology, in connection with their course in steam engineering. The volume has been carefully prepared, and should be quite useful. Readers of THE LOCOMOTIVE will be interested to know that the authors have drawn largely on the back numbers of this periodical for cuts and other matter.

THE famous Ferris Wheel is finally being taken apart, for shipment to New York. According to the *Chicago Tribune*, "It will take ten weeks to take the wheel to pieces. The car that was used for carrying the Krupp gun will be used for carrying the seventy-ton axle. The material will be taken in five trains of thirty cars each to New York city. There are 3,000 tons of metal in the wheel, and 500,000 feet of timber is needed for the false work. Taking the wheel down will be more dangerous than putting it up. Only one life was lost in erecting the big attraction. The expense of taking down, moving, and rebuilding the wheel will be $150,000. In New York it is to be placed at Thirty-seventh Street and Broadway. Old Vienna will be reproduced around it. Here the wheel had 3,000 electric lights; in New York the number will be doubled. The old Ferris Wheel Company goes out of existence, and a new company, composed of New York men, has been formed. Superintendent L. V. Rice has charge of the removal. During the fair the wheel went around 10,000 times, and carried 2,000,000 passengers. The largest single load was carried October 19th, when, at 12.30 o'clock, 1,768 people were in the cars. The largest day's business was October 10th, when 38,000 people were carried. October 9th, 10th, and 11th there were 114,000 passengers, the largest average for any three days."

THE *Pall Mall Gazette*, in an interview with one of the leading taxidermists of London, brings to light some curious facts about rare birds and their eggs. "Of course," said the great taxidermist, "you know I have made some dodos and a great auk. *No?* Evidently you are an amateur at taxidermy. My dear fellow, half the great auks in the world are not genuine. We make 'em of grebes' feathers and the like. And the great auk's eggs, too! We make the eggs out of fine porcelain. I tell you it is worth while. They fetch — well, one fetched £300 ($1,500) only the other day. That one was really genuine, I believe; but, of course, one is never certain. It is very fine work, and afterwards you have to get them dusty, for no one who owns one of these precious eggs has ever the temerity to clean the thing. That's the beauty of the business. Even if they suspect an egg, they do not like to examine it too closely. It is such brittle capital at the best. You did not know that taxidermy rose to such heights as that? It has risen higher. I have rivaled the hands of nature herself! One of the *genuine* great auks" — his voice fell to a whisper — "one of the *genuine* great auks *was made by me!* And, what is more, I have been approached by a syndicate of dealers to stock one of the unexplored skerries to the north of Iceland with specimens. I may — some day." — *Ex.*

The Average Speed of the "Campania" and "Lucania."

The Cunard steamer *Campania* has now completed a year's service, having started on her maiden voyage from Liverpool on April 22, and it will interest our readers to have official returns as to the performances during that period. By the kindness of the Cunard company we are enabled to give accurate details in the accompanying tables,* two of which give all the round voyages to date of the *Campania*, and the other two those of the *Lucania*. These tables scarcely require any comment, except, perhaps, to point out that on several voyages the vessels experienced heavy weather, the effect of which is reflected in the duration of the voyages and in the mean speed. We might have quoted from the logs regarding contrary winds, head seas, and a continuance of bad weather, and demonstrated that on some occasions the vessels were in this respect unlucky. The mean speed of all the passages, however, is really most satisfactory. The mean speeds for the round voyages out and home are summarized, separately, in the last of the tables given below.

WESTWARD VOYAGES OF THE "CAMPANIA"—1893–4.

No. of Voyage.	Left Roche's Point.	Arrived Sandy Hook.	Duration of Passage.			Total Distance.	Average Speed.
			d.	h.	m.	Knots.	Knots.
1	Apr. 23, 1:08 P.M.	Apr. 29, 5:24 P.M.	6	8	51	2,858	18.70
2	May 21, 2:45 "	May 27, 7:25 A.M.	5	21	15	2,812	19.92
3	June 18, 0:43 "	June 24, 0:30 "	5	16	22	2,880	21.11
4	July 23, 0:53 "	July 29, 11:42 P.M.	5	15	24	2,796	20.65
5	Aug. 20, 1:38 "	Aug. 26, noon.	6	2	57	2,781	18.93
6	Sept. 17, 1:23 "	Sept. 23, 3:10 A.M.	5	18	22	2,802	20.25
7	Oct. 15, 1:23 "	Oct. 20, 10:25 P.M.	5	13	37	2,783	20.83
8	Nov. 12, 0:50 "	Nov. 18, 5:00 A.M.	5	20	45	2,790	19.83
9	Mar. 11, 2:37 "	Mar. 18, 11:04 P.M.	6	13	02	2,863	18.24

[* These tables have been condensed from the original. ED. LOCOMOTIVE.]

EASTWARD VOYAGES OF THE "CAMPANIA"—1893-4.

No. of Voyage.	Left Sandy Hook.	Arrived Roche's Point.	Duration of Passage.			Total Distance.	Average Speed.
			d.	h.	m.	Knots.	Knots.
1	May 6, 11:40 A.M.	May 12, 9:47 A.M.	5	17	32	2,927	21.29
2	June 3, 10:42 "	June 9, 11:35 "	5	20	18	2,895	20.63
3	July 1, 8:47 "	July 7, 8:40 "	5	19	18	2,913	20.91
4	Aug. 5, 1:18 P.M.	Aug. 11, 0:50 P.M.	5	18	57	2,825	20.34
5	Sept. 2, 0:36 "	Sept. 8, 8:15 A.M.	5	15	04	2,816	20.84
6	Sept. 30, 10:37 A.M.	Oct. 6, 11:42 "	5	20	30	2,820	20.07
7	Oct. 28, 9:10 "	Nov. 3, 2:00 "	5	12	15	2,799	21.17
8	Nov. 25, 8:51 "	Dec. 1, 6:20 "	5	16	54	2,820	20.60
9	Mar. 24, 9:51 "	Mar. 30, 6:10 "	5	15	44	2,871	21.16

WESTWARD VOYAGES OF THE "LUCANIA"—1893-4.

No. of Voyage.	Left Roche's Point.	Arrived Sandy Hook.	Duration of Passage.			Total Distance.	Average Speed.
			d.	h.	m.	Knots.	Knots.
1	Sept. 3, 1:33 P.M.	Sept. 9, 0:45 A.M.	5	16	19	2,751	20.18
2	Oct. 1, 0:54 "	Oct. 6, 10:20 P.M.	5	14	01	2,782	20.76
3	Oct. 29, 0:40 "	Nov. 3, 9:07 "	5	13	02	2,780	20.90
4	Nov. 26, 1:20 "	Dec. 2, 0:37 A.M.	5	15	52	2,785	20.49
5	Feb. 25, 2:20 "	Mar. 4, 2:02 "	6	16	17	2,876	17.94
6	Mar. 25, 0:09 "	Mar. 31, 2:21 "	5	18	47	2,907	20.94

EASTWARD VOYAGES OF THE "LUCANIA"—1893-4.

No. of Voyage.	Left Sandy Hook.	Arrived Roche's Point.	Duration of Passage.			Total Distance.	Average Speed.
			d.	h.	m.	Knots.	Knots.
1	Sept. 16, 11:02 A.M.	Sept. 22, 9:53 A.M.	5	17	16	2,785	20.29
2	Oct. 14, 10:19 "	Oct. 20, 4:35 "	5	13	41	2,802	20.96
3	Nov. 11, 9:20 "	Nov. 18, 4:55 "	6	15	00	2,853	17.94
4	Dec. 9, 8:03 "	Dec. 15, 3:13 "	5	14	35	2,817	20.93
5	Mar. 10, 9:47 "	Mar. 16, 3:36 "	5	13	14	2,900	21.77
6	Apr. 7, 8:45 "	Apr. 13, 3:00 "	5	13	40	2,892	21.63

It will be seen that the mean speed of the *Campania* for the nine voyages of over 50,000 nautical miles has been 20.304 knots [23.38 miles], while the *Lucania* in her six voyages of over 33,500 miles has averaged 20.394 knots [23.48 miles]. The mean of all the outward [westward] voyages of the *Campania* was 19.83 knots, and on the homeward [eastward] voyages 20.779 knots. In the first run, which affects the mean considerably, caution was desirable, owing to the fact that the engines had not been for long under steam. In the case of the *Lucania* the mean of the six outward runs is 20.202 knots, and of the homeward runs 20.586 knots. It may be added that three years ago we gave detailed returns of performances by competitive liners, and that the highest mean over six or seven voyages was about 19.1 knots, so that on this comparison the *Campania* and *Lucania* are $1\frac{1}{4}$ nautical miles per hour ahead of any of the other vessels, including the *Majestic*, *Teutonic*, *New York*, and *Paris*.—*Engineering.*

MEAN SPEED ON ROUND VOYAGES.

Voyage.	*Campania.*	*Lucania.*
1	20.00 Knots.†	20.235 Knots.
2	20.275 "	20.86 "
3	21.01 "	19.42 "
4	20.495 "	20.71 "
5	19.885 "	19.855 "
6	20.16 "	21.285 "
7	21.00 "	. .
8	20.215 "	. . .
9	19.70 "	. . .
Means,	20.304 Knots. [23.38 miles.]	20.394 Knots. [23.48 miles.]

[† A knot, according to the British Admiralty, is 6,080 feet.]

[NOTE. We are aware that there are several mistakes in these tables, but they are of such a character that we cannot correct them with the data at hand, so we reproduce the figures as given in *Engineering*. For example, in the ninth westward voyage of the *Campania* the duration of the passage is evidently over *seven* days (*i. e.* 7 d. 13 h. 02 m.), according to the given dates of departure and arrival. Undoubtedly one of these dates is in error by an even day. — ED. LOCOMOTIVE.]

IN the January issue of THE LOCOMOTIVE, in connection with the table of the properties of steam, it was inadvertently stated that the pressure as read by the gauge is *greater* than the equivalent absolute pressure as reckoned from a vacuum — the fact being, of course, that the *absolute* pressure is the greater of the two. Slips of this kind are unfortunate, but in the present case nobody could be misled. All the rest of the article showed plainly that the intention was to count the absolute pressure as the greater, and we have no doubt that all of our readers noticed the slip and passed it by charitably.

Parker's Uncomfortable Plight.

Henry Parker, colored, an employe of the Pietet Ice Company's factory, is the victim of an amusing as well as a distressing accident. For more than two hours he was held a prisoner in a large boiler, and it was only by the liberal use of axle grease and the loss of all his clothing that he was finally rescued. Parker went into the boiler immediately after dinner Thursday to clean it out. The flues inside the boiler are arranged so that at one end there is some spring to them. The other end, where they connect with the boiler, is more solid. Parker backed unconsciously between the flues until he reached the end of the boiler. When he attempted to come back, however, he found to his surprise that his body was tightly wedged between the flues. Struggle as he would Parker could not release himself. His calls brought several men to the scene. When Parker explained his situation the first impulse of his fellow workmen was to

laugh. Two men went into the boiler to release him, but their combined efforts only brought shrieks of pain from the unfortunate. Some one telephoned to Dr. Mandeville Thum. A machinist was also sent for, and both arrived about the same time. All sorts of schemes were concocted by the physician, the machinist, and the now thoroughly frightened workmen. To cut through the boiler would take several hours, so that had to be given up as impracticable. With the most pitiful groans Parker insisted that the flue pipes were slowly closing in on him and squeezing out his breath. Dr. Thum hit upon a plan. He sent the machinist into the boiler with a knife. By tearing and cutting the machinist succeeded in removing most of Parker's clothing. A box of axle grease was then brought into use, and Parker's body was thoroughly greased where the pipes did not hold it. A rope was then tied just below his shoulders. All the men outside then caught the end of the rope and pulled. The hips appeared to be the principal place of resistance. A shriek came from Parker as the rope began to tighten, and then his body suddenly shot forward. All of his clothes were left behind and the man was pulled out of his prison as naked as the day he was born, his whole body glistening with grease. Parker's hips and one leg were a mass of bruises, and he had to be carried to his home in a neighboring alley. It will be two weeks before he is able to work again.—*Louisville Courier-Journal.*

A Boiler that Needed Repairs.

Once upon a time there was a man who had a knife. The blades of the knife, one by one, got so badly nicked and otherwise injured that new blades were substituted for them as occasion required. Finally the handle went to pieces, and a new one was provided. The question was then discussed at the grocery store whether this was the same old original knife or not. Some of the Solons of the village held that as it contained no portion of the original knife, it must be a different one. Others held that it was certainly the same knife, in spite of the repairs; and these men supported their claims by referring to several instances in which churches and other structures had been repaired in a similar manner, and pointing out that in cases in which the lease of the land on which they stood was to terminate with the life of the building, the courts had decided that the individuality of the building had not been destroyed by the repairing process. Whatever the merits of the case may have been, the story goes that the second of these arguments prevailed, and that it came to be universally admitted that the repaired knife was the same old knife, sure enough. But when this decision had been reached, the owner of the knife produced all the old blades and rivets and bits of handle, which he had saved up, and assembled them into a new knife. Then the question arose, if the repaired knife was the same knife as the original, then what knife was this patched-up affair that contained all the identical parts of the first one?

About this time, we imagine, the reader will be wondering what all this has to do with the heading of this article. Well, let him read what follows, and we fancy he will see the connection. "The Department of Workshops and Factories," says the *Columbus* (Ohio) *Dispatch*, "has received frequent complaints from citizens of Gahanna as to the condition of the boiler used at the Gahanna mill, owned by Frank E. Morgner. While the department does not claim to have jurisdiction over such matters, yet the complaints became so numerous that an inspection was made by Deputy Inspector J. H. Ellis, assisted by an expert boiler inspector. The flues and other parts of the boiler were found to be thoroughly demoralized, and several holes were punched in the boiler, as a

test and at the same time to insure its repair before again being used. The inspector recommends as follows: 'Remove all the old flues and put in new ones, remove the sheets over the fire grates and replace them with new sheets, and where the boiler has become thin and rusted cut out such places and patch; repair the blow-off plug, provide a new front support and a new breeching and stack, and provide substantial hand railings on stairways.' The citizens paid for the services of the boiler inspector.'

Electric Railway Dangers.

In the April issue of THE LOCOMOTIVE we published an article on this subject by Mr. H. C. Cushing, Jr. The following item from the *Scientific American* will be of interest in connection with Mr. Cushing's article:

"At a recent meeting at Washington of the National Electric Light Association, Mr. J. H. Vail, M.I.C.E., of New York city, brought forward a number of interesting cases of electrolysis. Among them were the following. A plumber in a Pennsylvania city was repairing a water pipe in a house, and on breaking a joint, an electric arc formed across the ends of the pipe. The house was not in the direct path of the railway circuit. Investigation followed, and it was proved beyond question that there was insufficient conductivity in the track system, and also that the earth did not afford a good return, though the tracks were well grounded. It was found that the railways current was traveling along all pipe systems in its effort to complete the circuit to the dynamos in the power station. Actual tests were made with standard instruments. From 135 readings of the ampere meter, it was found that the water pipes leading into the station carried an average current of 93 amperes. Further tests showed that with 23 cars in operation, 40 per cent. of the total current was carried by underground pipes. Another interesting case was brought to light by a fire in the basement of a house. After it was extinguished, it was found that the current of an electric railway system had been carried along the water pipe entering the house. It is believed that, by vibration of the floors, this pipe and a gas pipe were brought repeatedly into contact — each time forming an arc between them. In this way a hole was eaten into the gas pipe and the gas was ignited. After an analysis of the whole matter, Mr. Vail felt justified in recommending the adoption of the complete metallic circuit as the standard for the best railway practice."

A STRANGE accident happened to Mrs. G. M. Williams at her home on Second street recently, which proved exceedingly painful. She had nearly finished her Monday's washing and had a boiler full of clothes over a hot fire in the kitchen. While in the act of pushing the clothes under the water with a stick, an explosion occurred in the bottom of the boiler and nearly a gallon of the boiling water, accompanied by a burst of steam, was thrown over Mrs. Williams' head and shoulders. She was severely scalded on the head, right side of her face, and across her shoulder and bosom. — *Santa Rosa Democrat.*

WE have received one account of an explosion of some kind, which we do not exactly understand. It was in an electric light plant, and the report says that "it was found that the vacuum in the receiver had been reduced and that a large amount of steam had leaked in, causing the thing to explode." It is a relief to hear that "the damage is not heavy, save to the building, which has large holes punched in the walls."

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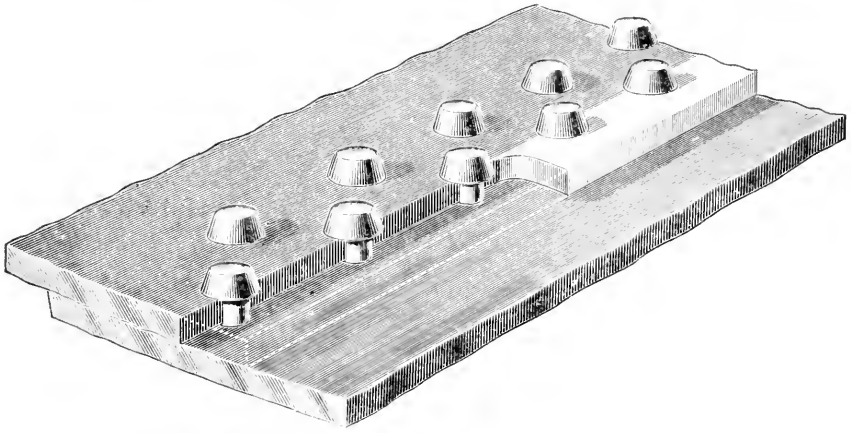
Some Notable Riveted Joints.

We have devoted so much space, in the past, to the discussion of riveted joints, and have called attention so many times to the importance of designing these joints properly, that there is some danger that readers of Fielding's works may classify us as physicians; for, says Fielding, "every physician hath his favorite disease," to which he attributes most of the ills of the flesh. Now we are quite willing to admit that practice with regard to riveted joints is much better than it used to be, and yet we find so many examples of poorly designed joints that it seems as though the time had hardly come when we could safely stop talking about them. In illustration of this statement we propose to mention a few cases that have come under our observation recently.



A FAULTY JOINT, AS "PREPARED" TO PASS INSPECTION.

The first case in order relates to a 48″ vertical tubular boiler, ten feet high, constructed of shell steel of 60,000 pounds tensile strength. The plates are $\frac{5}{16}$″ thick, and are single riveted, the diameter of the rivets being $\frac{5}{8}$″ and the pitch $1\frac{3}{4}$″. The heads are $\frac{3}{8}$″ thick, and there are 120 two-inch tubes, each 7′ 6″ long. The workmanship of the boiler is excellent in every respect, and so far as we know, the material is so, also. The only objectionable thing about the boiler is the joint. The diameter of the rivet being $\frac{5}{8}$″, it is fair to suppose that the diameter of the hole is $\frac{11}{16}$″, or 0.6875″. The pitch being 1.75″, the efficiency of the joint, so far as the net section of the plate is concerned, is

$$\frac{1.75'' - 0.6875}{1.75} = 60.7\,\%.$$

The area of an $\frac{11}{16}$″ hole being 0.3712 sq. in., the strength of one rivet, assuming the shearing strength of rivet iron to be 38,000 lbs. per sq. in., is $.3712 \times 38{,}000 = 14{,}100$

pounds; and the strength of a strip of the solid plate $1\frac{3}{4}''$ wide being $1\frac{3}{4}'' \times \frac{5}{16}'' \times 60{,}000$ lbs. = 32,800 lbs., we find that the efficiency of the joint, so far as rivet section is concerned, is $14{,}100 \div 32{,}800 = 43.0\%$. Here is a single riveted joint, therefore, which has an efficiency of only about 43 per cent., whereas with a change in design it might have had an efficiency of say 56 per cent. Now why is it that a good, reputable boiler manufacturer will put out a job like that, when he might just as well, and without more expense, have turned out one far better? The answer seems pretty evident. If the efficiency of this joint be computed on the assumption that the strength of the plate is 40,000 or 45,000 pounds to the square inch, it will be found that it comes out in the neighborhood of 60 per cent., and that the general proportions are pretty good. We infer, therefore, that the joint in question was made up from a templet that has been lying about the shop for many years — ever since the time when iron of this quality was the standard article in boiler construction. The makers are good, honest men, and they mean to turn out good work; but they are away behind the times — away back, somewhere "before the war." (A proper single-riveted joint for this boiler would be something like this: Diameter of rivets $\frac{3}{4}''$, pitch of rivets $1\frac{7}{8}''$, efficiency of joint, 56.6%.)

The next case we shall consider is that of two horizontal tubular boilers in the West. They are 72" in diameter and 16 feet long. The plates are of flange steel, $\frac{3}{8}''$ thick, with a tensile strength of 60,000 pounds per square inch. There are 92 $3\frac{1}{2}''$ tubes in each boiler, and the heads are of steel $\frac{1}{2}''$ thick. The longitudinal joints are double riveted, the rivets being $\frac{7}{8}''$ in diameter, and the pitch 3". Calling the rivet-holes $1\frac{3}{16}''$ in diameter ($1\frac{3}{16} = 0.8125$), the efficiency of the joint, so far as net section of plate is concerned, is

$$\frac{3'' - 0.8125''}{3''} = 72.9\%.$$

The area of a $1\frac{3}{16}''$ hole being 0.5185 sq. in., the shearing strength of a single rivet is $0.5185 \times 38{,}000 = 19{,}700$ lbs.; and as there are two rivets in a unit section of the joint (the joint being double riveted), the total shearing strength of the rivets in a unit section is 39,400 lbs. The strength of a strip of the solid plate 3" wide being $3'' \times \frac{3}{8}'' \times 60{,}000$ lbs. = 67,500 lbs., the efficiency of the joint, so far as rivet area is concerned, is $39{,}400 \div 67{,}500 = 58.4\%$. This is much less than the efficiency of the net section, and hence it follows that the joint is badly proportioned. The rivet area is too small. We incline to the opinion that this joint was originally calculated for C. H. No. 1 iron, of a tensile strength of 50,000 lbs., and that it has been used ever since, simply because the templets were handy, and the builder has never understood why the joint is not as good for steel of 60,000 pounds strength as it was for the iron for which it was calculated. With a factor of safety of 5, the safe working pressure on these boilers is 73 lbs. per square inch. The safety-valves had always been set at 100 lbs., and the owners of the boilers had expected to insure them for 110 lbs. pressure. A proper double-riveted joint for these boilers would be: Diameter of rivets $\frac{7}{8}''$, pitch of rivets $3\frac{1}{16}''$, efficiency of joint, 69.4 per cent. This would give a safe working pressure (with a factor of 5), of 87 lbs. per square inch.

The next case to which we wish to call attention relates to a horizontal tubular boiler of marine type. This boiler is 12 feet long and 90" in diameter. The shell plates are of $\frac{1}{2}''$ steel, of 60,000 lbs. tensile strength. There are two internal furnaces, each 32" in diameter, and 64 4" tubes. The longitudinal joints are double chain riveted, the rivets being $\frac{3}{4}''$ in diameter, and the pitch 2". Assuming the rivet-holes to be $1\frac{3}{16}''$ in diameter, the efficiency of the joint, so far as net section of plate is concerned, is

$$\frac{2'' - 0.8125''}{2''} = 59.4\%.$$

The size of the rivets being the same as in the last example, the shearing strength of the two rivets that occur in a unit section of the joint is 39,400 lbs., as before. The tensile strength of a strip of the solid plate 2″ wide is 2″ × ½″ × 60,000 lbs. = 60,000 lbs. Hence the efficiency of the joint, so far as rivet area is concerned, is 39,400 lbs. ÷ 60,000 lbs. = 65.7%. The net section of the plate is therefore the weaker, and the actual efficiency of the joint must be taken as 59.4%. With this efficiency and a factor of safety of 5, the safe working pressure on the boiler is 79.2 lbs. per square inch. The owners wished to insure it for 100 lbs. In a case of this kind, where the shell is not in contact with the fire, a smaller factor of safety than 5 might be allowed; but the point is, that the joint is badly proportioned, and that the double riveted joint actually used is scarcely better than a well-made *single riveted* joint. A single riveted joint (although we should not advise such a joint, of course), with rivets 1″ in diameter and a pitch of 2 3/16″ would give an efficiency of 51.4 per cent.; whereas the efficiency of the *double* riveted joint that was actually used was only 59.4%. We think that a double welt butt strap joint is the proper thing for this boiler. However, a common double riveted staggered joint, with rivets 1″ in diameter and pitched 3¼″ from center to center, would give an efficiency of 67.3 per cent., and this would allow a safe working pressure of 89.7 lbs. with a factor of safety of 5. A triple riveted lap joint, with 15/16″ rivets and a pitch of 3½″, would give an efficiency of 71.4 per cent. and a safe working pressure of 95.2 lbs., with the same factor as before. Finally, a double welt butt joint of the style shown in THE LOCOMOTIVE for July, 1891, on page 103, Fig. 5, would give an efficiency of 85.7 per cent., and a safe working pressure of 114.2 lbs. with a factor of 5, provided the rivets were 15/16″ in diameter and the pitch of the inner rows was 3½″.

Another case relates to a horizontal tubular boiler 60″ in diameter and 15 feet long. The shell is of iron, 5/16″ thick, with a tensile strength of 50,000 lbs. The longitudinal joints are of the kind known as "once-and-a-half" riveted — that is, they contain one row of rivets pitched 2″ apart, and a second row pitched 4″ apart. The rivet *holes* in each case are ⅞″ in diameter (⅞ = 0.875). So far as net section of plate is concerned, this joint is evidently weakest along the line of smallest pitch. Hence the efficiency of the joint, in this respect, is $\frac{2'' - 0.875''}{2''} = 56.2\%$.

The area of a ⅞″ hole being 0.6012 sq. in., the combined shearing strength of the three rivets that occur in a 4-inch section of this joint is 3 × 0.6012 sq. in. × 38,000 lbs. = 68,537 lbs. The strength of a section of the solid plate of equal width is 5/16 × 4″ × 50,000 lbs. = 62,500. It is evident, therefore, that the rivet section in this joint is much too great. In fact, the row of rivets in double pitch is altogether superfluous, for if it were entirely left out, the shearing resistance of the remaining single row of rivets would materially exceed the strength of the net section of the plate; and hence the efficiency of the joint would still be 56.2 per cent.! In other words, the joint, as actually constructed, is no stronger than a single riveted joint with ⅞″ holes pitched 2″ apart; and the additional row of rivets was a mere waste of time and material, to say nothing of the injury to the plate due to the punching of needless holes in it. A good double riveted joint for this boiler would be proportioned about as follows: Diameter of rivet ¾″, pitch of rivets 2⅞″, efficiency of joint 71.7 per cent.

In another case, similar to the one just mentioned, there are six horizontal tubular boilers 54″ in diameter and 16 feet long. The shells are of steel, 5/16″ thick, with a tensile strength of 55,000 lbs. to the square inch. The longitudinal joints are "once-and-a-half" riveted, the pitch in the close row being 2″. The diameter of the rivets is

$\frac{3}{4}''$, the holes being $1\frac{3}{16}''$ ($= 0.8125''$). The efficiency of the joint, so far as net section of plate is concerned, is $\frac{2'' - 0.8125''}{2''} = 59.4\%$.

The area of a $1\frac{3}{16}''$ hole being .5185 sq. in., the combined shearing resistance of the three rivets that lie in a 4-inch section of this joint is $3 \times .5185 \times 38{,}000 = 59{,}100$ lbs. The tensile strength of a strip of the solid plate 4" wide is $4'' \times \frac{5}{16}'' \times 55{,}000$ lbs. $= 68{,}750$ lbs. Hence the efficiency of the joint, so far as the shearing is concerned, is $59{,}100 \div 68{,}750 = 86\%$. The rivet area is therefore excessive; and in this case, also, the row of rivets in double pitch could have been omitted without material loss of strength: for the omission would only reduce the efficiency of the joint to 57.3 %.

Sir William Fairbairn, many years ago, stated the efficiency of a single riveted joint to be 56 per cent., and the efficiency of a double riveted one to be 70 per cent. Of course he intended to signify that these were the limits practically obtainable with careful design and construction; but it has long been the fashion, even among engineers who ought to know better, to allow 56 per cent. and 70 per cent. for single and double riveted joints, respectively, without the least regard to the actual proportions of the joints. The cases we have already given in the present article ought to satisfy anyone of the fallacy of this proceeding; but if they fail to do so, here is a case that seems to us to be particularly convincing. Upon examining a boiler in New England that was recently offered for insurance, we found it to be constructed of steel of 60,000 lbs. tensile strength. It was 66" in diameter and the plates were $\frac{3}{8}''$ thick. The longitudinal joints were double riveted, the rivets being $1\frac{1}{16}''$ in diameter (holes $\frac{3}{4}''$) and the pitch being $2\frac{5}{16}''$. The decimal equivalent of $\frac{5}{16}''$ being 0.9375, the efficiency of this joint, so far as net section of plate is concerned, is

$$\frac{2.9375'' - 0.75''}{2.9375''} = 74.5\%.$$

The area of a $\frac{3}{4}''$ hole being 0.4418 sq. in., the shearing resistance of the two rivets that occur in a unit section of the joint is $2 \times 0.4418 \times 38{,}000 = 33{,}580$ lbs. The tensile strength of a strip of the solid plate $2\frac{5}{16}''$ wide being $\frac{3}{8}'' \times 2\frac{5}{16}'' \times 60{,}000$ lbs. $= 66{,}100$ lbs., the efficiency of the joint, so far as shearing is concerned, is $33{,}580 \div 66{,}100 = 50.8\%$. The rivet section, therefore, is altogether too small; and the actual strength of this *double riveted* joint is less than the nominal strength (according to Fairbairn) of a *single riveted* joint! The most obtuse persons would readily understand that disastrous consequences might result if one should merely note that the boiler is double riveted, and then, without calculation, allow an efficiency for the joint of 70 per cent.

We have spoken, thus far, only of joints that were put in by the makers in good faith, with an honest belief that they were above reasonable criticism. We are sorry to say, however, that we find defective joints that do not come under this head. Rivets are sometimes driven without much regard for good workmanship, and the resulting joints necessarily have a low efficiency. A workman who is driving rivets badly is pretty apt to know it; and if he lets poor work go out, with the knowledge that somebody's life and property is likely to be imperiled by his poor workmanship, he is a rascal. This may seem like strong language to some of our readers, but we think it is abundantly justifiable by the facts. Consider, for example, the case shown in the illustration on the first page of the present issue. The eight boilers in this battery were new last year, and were insured in the Hartford Steam Boiler Inspection and Insurance Company. Before the policy of insurance was issued the usual careful internal inspection was made, and the inspector reported the boilers in good condition. The policy was then issued, and the battery was run, in fancied security, for one year. A short time

ago our inspector again made an internal examination, and found that on some of the sheets *in every one of these boilers* the internal lap was very slight. The sheets had been sheared too short for a double row of rivets, and in some of them one of the rows of rivets *had only half a hole in the plate!* This defect was very obvious at the second inspection, and it would have been so at the first one, except that somebody, with devilish ingenuity, had "prepared" the faulty laps so that they might pass inspection. A kind of putty had been mixed up of red lead, iron filings, and other ingredients, and the bad work had been covered up by building out a continuation of the plate *in putty*. The work had been so skillfully done that it deceived even the experienced inspector who examined the boilers. The color and texture of the plate had been so well imitated that the joint looked sound and proper. At the time of this last inspection some of the putty was still intact, except that the edge was a little ragged. In other places the heat had cracked and disintegrated it, and portions of it had fallen off.

Within a year we have found three short-sheet jobs from the boiler-makers who turned out the putty-joint just referred to; and yet these men have an excellent reputation, and we believe that they intend to do honest work. The short sheets were probably passed by somebody in the shop who hoped to cover up his own carelessness or incompetence, and who, to accomplish this end, was willing to jeopardize the lives of innocent customers of the firm for which he worked.

Inspectors' Report.

APRIL, 1894.

During this month our inspectors made 7,646 inspection trips, visited 16,003 boilers, inspected 7,061 both internally and externally, and subjected 642 to hydrostatic pressure. The whole number of defects reported reached 11,355, of which 1,071 were considered dangerous; 44 boilers were regarded unsafe for further use. Our usual summary is given below:

Nature of Defects.	Whole Number.	Dangerous.
Cases of deposit of sediment,	969	55
Cases of incrustation and scale,	2,006	66
Cases of internal grooving,	118	10
Cases of internal corrosion,	633	45
Cases of external corrosion,	826	58
Broken and loose braces and stays,	228	112
Settings defective,	340	57
Furnaces out of shape,	412	20
Fractured plates,	342	62
Burned plates,	286	23
Blistered plates,	289	5
Cases of defective riveting,	1,334	84
Defective heads,	127	95
Serious leakage around tube ends,	1,642	179
Serious leakage at seams,	506	38
Defective water gauges,	379	60
Defective blow-offs,	160	48
Cases of deficiency of water,	16	11
Safety-valves overloaded,	35	8

Nature of Defects.	Whole Number.	Dangerous.
Safety-valves defective in construction,	127	39
Pressure gauges defective,	520	55
Boilers without pressure gauges,	11	11
Unclassified defects,	49	0
Total,	11,355	1,071

Boiler Explosions.

APRIL, 1894.

(78.) — By a boiler explosion, which occurred on April 2d in Monroe county, Ind., near Tompkinsville, Alexander Ritter, the owner of the mill, and two brothers named Fowler, were instantly killed. Two other persons were badly injured.

(79.) — On April 3d, a boiler exploded at the Climax coal works, near Brownsville, Fayette county, Pa. The boiler was on a pumping-boat, and the boat was shattered to pieces. Henry Connelly, who was in charge of the boat and of the night work, was instantly killed, and his body was blown into the Monongahela river. Connelly had been through two boiler explosions previously, in both of which he was injured

(80.) — By the explosion of a boiler in Salem, near Baylis, Ill., on April 5th, Josiah Oliphant was instantly killed, and Thomas Miller and Samuel Oliphant were badly injured.

(81.) — A boiler exploded, on April 8th, at the Peerless Oil Company's works at North Baltimore, near Toledo, Ohio. Engineer Clarence Boggs was blown 40 feet through the air, and considerably injured.

(82.) — On April 7th, a terrible boiler explosion occurred in the little village of Lancaster, ten miles east of Clay City, Ind. Christian Weber, Louis Weber, Lester Rinehart, and Clifford Rinehart, were instantly killed, and Charles Schaeffer and John Shepper were injured so frightfully that recovery is impossible. The mill was completely demolished, and the place where the boiler stood was swept clean. Large pieces of the boiler were thrown to a distance of 1,000 feet, and one piece of pipe, ten feet long, was blown fully a mile away, where it was found sticking in the roof of a barn. The body of Lester Rinehart was blown across a small pond, and was found on the further bank, 300 feet from the site of the boiler. The property loss was estimated at $30,000.

(83.) — By the explosion of a boiler near Whitehall, Mich., on April 9th, Augustus Anderson, the fireman, was instantly killed, and Otto Sullivan, Martin Lynch, Frank Shippy, Allen Critchett, Loraine Critchett, and Emory Sterns, were injured so badly that they died during the day.

(84.) — On April 9th, the central boiler of a nest at the Harry E. colliery, operated by Simpson & Watkins, at Brodericks, near Forty Fort, Pa., exploded with terrific force, but fortunately without causing loss of life. The entire boiler-house was wrecked, the roof being blown off and the side walls blown out. The boiler, in its flight, crossed the main roadway and the Lehigh Valley railroad tracks, landing 200 feet away from its original position. Two firemen, Thomas Welch and Thomas Fleming, who were twenty feet from the boiler at the time of the explosion, were blown through a door about forty feet further, and were seriously injured, though not fatally so.

(85.)—A boiler exploded, on April 12th, in the rod department of Oliver & Roberts' wire mill, on Ninth street, South Side, Pittsburgh, Pa. We have not learned further particulars.

(86.)—On April 13th, a boiler exploded near Celina, Ohio, at a place where the Mackinaw Drilling Company were drilling an oil well. John Duddeson and George Martz were in the engine room repairing some machinery. Martz was struck by a piece of the boiler and blown about 100 feet away, landing in a field. His face and arms were badly cut, and one wrist was broken. Duddeson was also fearfully bruised and scalded, and he cannot recover. Large pieces of the boiler were thrown to a distance of 800 feet, and it is said that some fragments, weighing half a ton or so each, were found as far away as 1,200 feet.

(87.)—Five men were riding on Engine No. 102 of the Philadelphia & Reading railroad, near Schuylkill Falls, on April 13th, when the boiler of the locomotive exploded. None of the men were injured, and their escape was considered to be almost miraculous.

(88.)—The boiler in George Shipley's saw-mill, nine miles southeast of Columbia City, Ind., exploded on April 16th with terrific force. The building was totally destroyed. Ami Hiveley was struck by a piece of the boiler and died an hour later. George Shipley had his shoulder crushed and a hand broken. James Shipley received a gash in the head. A piece of the boiler weighing a thousand pounds was carried sixty rods.

(89.)—On April 16th, a boiler exploded in Breece's hub and spoke factory at Bainbridge, a small town near Springfield, Ohio. The mill was totally wrecked, and windows in buildings within a radius of five blocks were shattered. Engineer Nathan Weatherby was instantly killed, and Frank Breece, brother of the owner of the mill, was injured so badly that he died within a few hours. Samuel Husted suffered a compound fracture of the left leg, and in all probability amputation will be necessary to save his life. Grant Martin's skull was crushed and he was badly scalded. Charles Bosler's left leg was broken and scalded. Edward Everhart was badly scalded, and he was also struck by flying timbers and severely injured about the head. The home of David Ogle, half a block from the mill, was demolished by flying timbers and fragments of the boiler. Mrs. Ogle received severe wounds, none of which, however, are believed to be fatal. There is little doubt that the explosion is attributable to some sort of defect in the boiler. A few days before, Engineer Weatherby had noticed a leak, and had refused to work until the boiler was repaired. A boiler maker had thereupon visited the place, repaired the leak, and pronounced the boiler safe and in good condition. Neither Weatherby nor Breece had any confidence in it, however, and they stayed away from it as much as possible, and freely expressed their fears to fellow workmen.

(90.)—On April 17th, two boilers exploded in the rod mill at Newcastle, Pa., demolishing the boiler-house, breaking some valuable machinery, and badly injuring a man named Thompson. The loss will run up into thousands, and will cause the works to shut down for a time.

(91.)—A boiler exploded, on April 20th, in a back room over the Elephant shoe store, in Vincennes, Ind. A big crowd rushed up stairs and found that Dr. Clymer and Joseph Souden were badly scalded and bruised. The boiler had been purchased recently by Dr. Clymer, who intended to use it in connection with vapor baths. He was

testing it *by steam pressure*, and although it was guaranteed to stand 80 pounds it exploded at 26. The doctor was severely injured about the head and hips, and Mr. Souden was badly scalded as well as bruised about the head.

(92.) — On April 18th, a boiler exploded in a saw-mill belonging to G. W. Evers, of Bell Center, eleven miles north of Boscobel, Wis. Mr. Evers was seriously injured, and the mill was partly wrecked.

(93.) — James Sterrit, Patrick Keefe, and John Rowan were instantly killed, on April 18th, by the explosion of a boiler at Keokuk, Iowa. Charles Jones's skull was also fractured, his head and neck were scalded, and his whole body was bruised. He will die.

(94.) — On April 24th, a boiler exploded at Houser & Foutz's tile mill, near Huntington, Ind. Elmer Anson was killed, and David Houser and Adam Foutz were fatally injured. The mill was wrecked. The boiler had been purchased at second hand, and the explosion occurred on the second day after it had been fired up.

(95.) — One of a battery of ten boilers exploded on April 24th at the Excelsior colliery, at Shamokin, Pa. The remaining nine boilers were displaced, and the boiler-house was wrecked. James Rhoades, the fireman, was injured.

(96.) — On April 24th one of the two stationary boilers in the Santa Fé round-house at Newton, Kas., exploded with terrific force. The boiler was torn to fragments, and the round-house was badly damaged. One employe was near the boiler when it burst, but he very fortunately escaped with slight injuries. The damage is estimated at about $1,000.

(97.) — A boiler in Roberson's steam saw-mill, at Williamston, N. C., exploded on April 30th. Isaac Bright was killed outright, and seventeen other men were badly injured, two of whom will probably die. Among the injured were several women who had gone to the mill to take breakfast to the hands. The shock of the explosion was felt seven miles away, and until the fact of the explosion became known, it was generally supposed that an earthquake had occurred.

(98.) — On April —th, a boiler exploded in Iroquois, S. D. So far as we could learn, nobody was hurt; though Joseph A. Pement had a narrow escape.

(99.) — A slight boiler explosion occurred, on April ——, in the electric lighting station at Barry, near Quincy, Ill.

MR. W. R. RONEY has kindly sent us a copy of the paper on *Mechanical Draft*, read by him at the Montreal meeting of the American Society of Mechanical Engineers. The paper is too long to be reproduced in THE LOCOMOTIVE, but those interested in the subject will find it given in full in the forthcoming fifteenth volume of the *Transactions* of the society. It contains many interesting points. The author discusses the disadvantages of chimneys, and proposes to substitute for them an exhaust fan, driven by an auxiliary engine. He states that "it cannot be considered good engineering to attach an economizer to a chimney less than 200 feet in height," and he adds that "the best working economizers, in connection with chimneys, are those where the chimney is considerably over 200 feet high." With mechanical draft an economizer can be used, of course, under all circumstances. The results of tests made on nine steam

plants, running under forced draft, are given at the end of the paper. We think Mr. Roney is a little over-sanguine about mechanical draft, but, nevertheless, we found his paper of considerable interest.

On June 13, the Royal Society gave a soirée, to which ladies were invited. A number of interesting things were exhibited. Mr. J. W. Swan showed some specimens of gold-leaf prepared by him, which are only four one-millionths (.000,004) of an inch thick. They were made by electro-plating with gold on some of the wonderfully thin sheets of copper that Mr. Swan produced in a similar manner, some years ago. After the gold had been deposited, the copper foil was dissolved away by perchloride of iron, leaving only the gold. The gold-leaf so prepared has a thickness of from one-fifth to one-tenth that of the thinnest films that can be produced by the old-fashioned process of beating. Mr. J. W. Kearton exhibited some "magic mirrors" which he had made. These mirrors are metallic, and look perfectly plain. When a ray of sunlight is reflected from them to a screen, however, a pattern appears on the screen in dusky lines. These "magic mirrors" were invented by the Japanese, who engrave a pattern on the back of the mirror, and then polish the front. "The portions corresponding to the raised parts on the back stand up more rigidly to the polishing tool, and therefore suffer a greater reduction, the evidence of which is afforded by the reflected beam." Mr. Kearton's mirrors are prepared in a different manner. He etches the pattern on the face of the mirror, and then polishes the mirror till the pattern is no longer visible. It will still show, however, when the ray of sunlight is reflected on a screen. Professor C. V. Boys showed photographs of the apparatus used by him to determine the average specific gravity of the earth, the apparatus itself being too delicate to be brought to the hall for exhibition. His method is substantially the same as that used by Cavendish, a century ago, except that the present apparatus is far more delicate and accurate. Professor Boys has been working on this problem for five years, and he finds that the specific gravity of the earth, taken as a whole, is 5.527. It is believed that this result is correct to within one-fiftieth of one per cent. It is certainly by far the best determination of the specific gravity of the earth that has yet been made.

Professor Dewar, an eminent English scientist, has recently been investigating the phenomena attending the production of great cold, and many of his lecture experiments have been striking and beautiful. In one instance he caused a soap bubble to float down into a vessel of liquid air. The intense cold froze the bubble, and the professor cracked it in two. The halves continued to float like egg-shells on the surface of the liquified air, and they gradually filled with snow, which was precipitated by the cold from the moisture in the air of the room. His method of transporting liquid air deserves mention. He uses a double-walled glass vessel, the space between the walls being completely exhausted by a good air-pump. A few drops of mercury are then introduced into the vacuum jacket so formed, and the liquid air is poured into the inner vessel. The slight vapor arising from the mercury is instantly condensed on the inner vessel, forming a coating of mercury of great brilliance. The vacuum jacket is an almost perfect non-conductor of heat, and the mercury film reflects nearly all the *radiant* heat that strikes the vessel. The liquified air in the inner compartment is therefore well protected; but to make the protection more perfect still, Professor Dewar packs the whole apparatus in solid carbonic acid gas!

The Locomotive.

HARTFORD, JUNE 15, 1894.

J. M. ALLEN, *Editor.* A. D. RISTEEN, *Associate Editor.*

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AT about midnight of May 7th, a mob of nearly 200 strikers and others went to the mines of Thomas Price, near Birmingham, Ala., and blew up the boiler and engine with dynamite. Although this is an instance in which a boiler was intentionally destroyed, it is plainly not one of the kind of cases contemplated in our recent comment on this subject.

A STEAM pipe burst in the basement of the Humboldt Park school, in Chicago, on April 9th, causing a panic among the pupils. In the rush of the children to escape from the building, one boy was killed, and over a score were crushed and trampled upon. Fourteen children were taken to the St. Elizabeth hospital, and many others were carried to their homes by the police.

MR. C. J. H. Woodbury, vice-president of the Boston Manufacturers' Mutual Fire Insurance Company, will sever his active connection with that company on July 1st, and will enter the service of the American Bell Telephone Company. Mr. Woodbury has been connected with the Mutual Fire company for over sixteen years; and in entering upon his new duties he will have the good wishes of an uncommonly wide circle of friends.

Boiler Compounds.

WE desire to acknowledge the *Report for 1893* of the Hannover (Germany) Verein zur Ueberwachung der Dampfkessel. We note, on page 18, an analysis of "Klewitz's Anti-Incrustation Compound," from which we can quote without giving offence to any one, as this compound, so far as we know, has never been put on the American market. "This compound," says the report, "is a brownish substance, with a distinct odor of tobacco. When treated with water the compound dissolves, leaving only a slight residue, and the solution is of a brownish color, with a strongly alkaline reaction. A careful chemical analysis shows that the compound consists almost entirely of crude carbonate of soda, the brown color and characteristic smell of which are due to the addition of some sort of an extract, or infusion, of tobacco. When the slight insoluble residue, referred to above, was examined under the microscope, it was seen to consist of vegetable cellular matter. Tannin and sugar were not present in the solution. A quantitative analysis showed the percentage composition of the compound to be as follows: Car

bonate of soda, with slight impurities, 56.3 per cent.; water, 40.0 per cent.; organic substances (of vegetable origin), 3.7 per cent. Klewitz's compound therefore consists of hydrated carbonate of soda (containing about 56 per cent. of the solid salt), to which extract of tobacco has been added, for the purpose of preventing people from recognizing the true composition of the compound. The presence of tobacco extract can only be regarded as a sign of adulteration of the soda, and it may serve a good purpose in warning would-be customers against the use of the compound." The idea that this report is intended to convey is, that there is no use in paying a big price for soda ash that has been adulterated with tobacco, or any other inert substance, when the straight, *un*-adulterated soda ash may be had cheaply. So much about this foreign compound. About those manufactured or sold in this country, it may be said that in many of them soda ash is the active ingredient, and that to these the criticisms of our German friends apply with full force. There are other compounds, of course, in which the base is petroleum, tannin, eucalyptus, and so on; but an adequate discussion of these would require more space than we can devote to it, at present.

The Evolution of the Match.

The lucifer match has attained its present high state of perfection by a long series of inventions of various degrees of merit, the most important of which resulted from the progress of chemical science. Starting from the ingenious tinder box and lyrstan of Saxon ancestors, the first attempt, so far as I know, to improve on the old sulphur match was made in 1805 by Chancel, a French chemist, who tipped cedar splints with a paste of chlorate of potash and sugar. On dipping one of these matches into a little bottle containing asbestos wetted with sulphuric acid and withdrawing it, it burst into flame. The contrivance was introduced into England some time after the battle of Waterloo, and was sold at a high price under the name of Prometheans. I remember being struck with amazement when I saw a match thus ignited. Some time after this a man named Heurtner opened a shop on the Strand, opposite the church of St. Clement Dane. It was named the Lighthouse, and he added this inscription to the mural literature of London: "To save your knuckles, time and trouble, use Heurtner's euperion."

An ornamental open moirée metallique box containing fifty matches and the sulphuric acid asbestos bottle was sold for one shilling. It had a large sale, and was known in the kitchen as the Hugh Perry. Heurtner also brought out vesuvians, consisting of a cartridge containing chlorate of potash and sugar, and a glass bead full of sulphuric acid. On pressing the end with a pair of nippers, the bead was crushed and the paste burst into flame. This contrivance was afterwards more fully and usefully employed for firing the gunpowder in the railway fog signals. We now come to Walker. He was a druggist at Stockton-on-Tees, and in 1827 produced what he called congreves, never making use of the word lucifer, which was not yet applied to matches. His splints were first dipped in sulphur and then tipped with the chlorate of potash paste, in which gum was substituted for sugar, and there was added a small quantity of sulphide of antimony. The match was ignited by being drawn through a fold of sand paper, with pressure; but it often happened that the tipped part was torn off without igniting, or, if ignited, it sometimes scattered balls of fire about, burning the carpet and even igniting a lady's dress. These matches were held to be so dangerous that they were prohibited by law in France and Germany. The first grand improvement in the manufacture took place in 1833 by the introduction of phosphorus into the paste,

and this seems to have suggested the word lucifer, which the match has ever since retained. When phosphorus was first introduced to the match-maker its price was four guineas a pound, but the demand became so great it had to be manufactured by the ton, and the price fell to half-a-crown a pound.—*Notes and Queries* (London).

Boiler Explosions in Germany Since 1877.

In the *Report for 1893* of the Hannover Verein zur Ueberwachung der Dampfkessel, we find the following statistics of the boiler explosions that have occurred in Germany from 1877 to 1892, inclusive.

BOILER EXPLOSIONS IN GERMANY SINCE 1877.

Year.	No. of Explosions.	No. Persons Killed.	No. persons seriously injured.	No. persons slightly injured.	Total No. of persons killed and injured.
1877	20	21	14	23	58
1878	18	10	5	17	32
1879	18	36	10	32	78
1880	20	10	5	14	29
1881	11	8	18	21	47
1882	11	19	14	15	48
1883	14	23	8	24	55
1884	14	12	11	22	45
1885	13	11	2	9	22
1886	16	10	5	8	23
1887	14	17	5	61	83
1888	15	4	3	4	11
1889	16	6	5	17	28
1890	16	9	1	11	21
1891	10	0	3	7	10
1892	18	12	11	18	41
Totals.	244	208	120	303	631

Bullet-Proof Coats.

The daily papers have said so much about the Dowe bullet-proof coat, that the following letter, recently published in *Engineering*, possesses considerable interest. It will be remembered that Mr. Hiram S. Maxim, of Maxim machine-gun fame, claimed to have also invented a bullet-proof coat, the secret of which he would sell for seven shillings and sixpence, cash. His letter is as follows :

"As there has been so much in the papers during the last week regarding me and my cuirass, I think it is nothing more than right that I should give my friends connected with the scientific world a few facts relating to the affair. During the past few months a great deal has appeared in the English press concerning a new 'bullet-proof cloth,' or a 'bullet-proof coat,' which had been invented by a German tailor. A couple of show-

men brought the German and his alleged invention to England for the purpose of exhibition before the British public. The device, however, instead of being a bullet-proof cloth, was, in my opinion, simply a piece of armor-plate sewn up in a bag. Had it been brought and exhibited at a music-hall as a clever juggling trick, it might have been highly amusing to the unscientific who are not acquainted with the laws of dynamics, but they were not content to exhibit the thing in its legitimate sphere; they entered the realm of science, claimed that it was a new scientific discovery, and succeeded in getting some of the best men, from His Royal Highness the Commander-in-Chief, down, to see their experiments. The great number of high officials and scientific and technical men who went to see it, and the publicity that was given to it by the press, brought it before everybody, and the claim set forth was an open challenge to me, as much as to any other scientific man in England. I saw the trick at once, and claimed that I had something better and lighter, the secret of which I would sell for 7*s.* 6*d.*, cash, and that the substance which I proposed to use was a compound of organic and inorganic matter. This was set forth in a letter which I wrote to the newspapers, and I offered to show my alleged invention and to sell the secret on a certain day. On that occasion, the London terminus of the railway that runs to Erith was simply overwhelmed with people wishing to go to Erith, and the number that went was only limited by the transportation facilities that the railway was able to offer. Many went to towns near Erith and walked across country. Some of my friends who were on the train have informed me that every one was talking about it, saying that Mr. Maxim was a very clever man, that he had probably made a very marvelous invention, and that iron-clads would likely go out of use, because he probably had some very light bullet-proof cloth that would resist all kinds of shots, even [from] large guns. One gentleman was anxious to have a complete suit off Mr. Maxim's new cloth to wear under evening dress, so that he could stand up and be shot at from all sides with a military rifle to amuse his friends. I must confess I had not the remotest idea that my 7*s.* 6*d.* cash secret would be taken in such dead earnest.

"The crowds that assembled at Erith was so great and so unruly that it was impossible to conduct the experiments in anything like a satisfactory manner, and, notwithstanding that I had a considerable number of men to assist me, the crowd broke down all barriers, mounting my table, and swarming over everything. I had provided myself with scales and a two-foot rule, and I asked the gentlemen to stand back and allow me to show them what my cuirass measured, and how much it weighed. I said I had agreed to make something which would beat Herr Dowe's cuirass, and to employ certain organic and inorganic substances, and I had found that the most suitable inorganic substances were iron and nickel, and for the organic substance a small percentage of carbon. When, however, they found out that my cuirass was nothing but a steel plate in a bag, that the process of manufacture which I described to them was nothing but the process of steel-making, they were exceedingly indignant, and about 100 of them, headed by a very pompous officer, who had come down with two orderlies, left in a great huff. They were perfectly furious and said they had been 'sold.' About 600 remained behind, and a large number of shots were fired at the cuirass, which had a larger protected area for its weight than Herr Dowe has ever shown. It was simply a piece of very fine, highly-tempered steel, one-quarter of an inch thick. Two shields were shown, one sewn up in a bag and the other covered with felt.

"At Herr Dowe's demonstration on the night of the 5th instant [ultimo?] to prove that his cuirass was all that he claimed for it, the area fired at was about 8 inches by 11 inches, and it was claimed that the weight was $11\frac{3}{4}$ pounds. They would not submit,

however, to the two-foot rule and scales. We are now able to provide armor-plates for the Maxim guns which will stop the small-bore projectile, and which weigh 7 pounds to the square foot, and this I think all scientific men would be willing to back against all other substances, weight for weight. I hear from Germany, on pretty good authority, that Herr Dowe's armor-plate is a piece of very hard aluminum bronze; but this, as we all know, is never quite as strong as good steel. The amount of abuse which I have received for giving away this little trick is simply wonderful. Had I been a pirate and sunk half the ships on the Thames it could not have been worse.

Yours truly,

June 6, 1894. HIRAM S. MAXIM."

In connection with this letter we have interviewed Dr. Richard J. Gatling, the inventor of the famous machine-gun that bears his name. Dr. Gatling said that although he does not know the actual construction of Herr Dowe's cuirass, he is inclined to disbelieve in the theory that it consists simply of plates of aluminum bronze, or even of steel. He said that he has often fired lead bullets through steel plates a quarter of an inch thick, and that it is quite easy to penetrate boiler plate that is $\frac{3}{8}''$ thick. He added that the rifle musket about to be adopted by the United States navy will penetrate steel plates that are half an inch thick. In view of these facts it would seem that a cuirass made of solid steel plates would be quite ineffective, when struck by a bullet squarely, unless it were half an inch thick, at the very least. Furthermore, he could see but little advantage in wearing such a cuirass, if it were in contact with the body; for a bullet fired from a good modern rifle musket, he said, will strike as heavy a blow as a sledge hammer in the hands of a muscular laborer; and a good solid blow with a sledge-hammer, against the pit of one's stomach, would hardly be calculated to stimulate one's ardor for more fighting. Dr. Gatling thought that if the ideal bullet-proof clothing were ever invented, it would consist of a woven fabric, tough, heavy, and flexible, and probably metallic, which would hang out from the body at a considerable distance. A bullet, striking against this sort of a yielding substance, would transmit a considerable part of its momentum to the armor, and the force of the blow sustained by the wearer would be greatly lessened. The soldier might be knocked down by the shock, and he would very likely be bruised, and he might possibly have some bones broken; but in most cases he would probably escape with a severe shaking up. In order to secure *penetration*, the high velocity of the projectile must be preserved up to the time of striking the body. If the armor is movable, the bullet will set it in motion; and although the total *momentum* will be unchanged, it will be distributed through a comparatively large mass, and hence the *velocity* will be greatly reduced, and the penetrating power will be lost. These are the properties of the ideal "bullet-proof coat"; but it does not appear that they have yet been realized in practice.

While interviewing Dr. Gatling, we could not resist the temptation to ask him how it came about that so non-belligerent and peace-loving a citizen as himself should invent such an infernal engine of destruction as the Gatling gun. "My dear sir," he said, "my gun is an instrument for the preservation of *peace*. I have many letters in my possession describing the moral effect of the gun. Howling mobs, ripe for any sort of violence, melt away into nothingness at the mere sight of it, the men suddenly remembering domestic matters that require immediate attention at their own firesides; and streets filled with the shouts of the multitude speedily become transformed into desert wastes, so far as any sign of man is concerned. I will tell you how I came to invent the gun, though I have seldom spoken about this point. I was living at Indianapolis at the time of the

war, and many raw regiments came there to be drilled before starting for the South. When the day for the final departure of one of these regiments came, the disconsolate mothers and sisters and sweethearts, and the tearful wives with babies in their arms, came to bid the soldiers farewell. The leave-takings were piteous — Oh! most heartrending; but the soldiers went away, and after a time the bodies of many of them would be returned in boxes, by express, and the loving ones that had bade them farewell so shortly before were filled with grief inconsolable. I remember these touching scenes most vividly, and they beggar description. I remember one morning there were eighteen bodies received, and I learned that of these not more than three or four had been killed by bullets; the others had died from disease and from exposure incident to the hardships of war. I wondered if this fairly represented the proportion of deaths from like causes throughout the army, and I found, on investigation, that only about one man in four is killed by bullets in modern warfare. Then I bethought me how a war could be carried on with fewer men, and I devised a gun that would do the work of a hundred men. One man might go to the war and work the gun, and the other ninety-nine could stay at home and carry on the arts of peace. This was the real incentive I had, so you see I was not such a blood-thirsty creature as might be imagined; for I was trying to save as many as I could of those scenes of distress and despair that were so deeply graven on my mind at Indianapolis. The machine-gun ought not to increase the carnage of war, but rather to decrease it. The tactics of armies have been changed to correspond with the new appliances, and machine-guns and smokeless powder have done much to preserve the peace, by making wars almost impossible, or, at least, by giving them such a forbidding aspect that few nations would engage in one until the last possibility of an amicable adjustment of differences, by arbitration, diplomacy, or otherwise, had been exhausted."

The following extracts from *The Broad Arrow*, an English naval and military paper of high standing, indicate that Mr. Maxim's exhibition at Erith was considered, by those who ought to know, to be unworthy of him. "Mr. Hiram Maxim may be a very clever man, but he is certainly not a wise one. What his object could be in inviting so many distinguished officers on a wild-goose chase down to Erith, it is hard to imagine. It can scarcely have been the desire for advertisement, since Hiram Maxim and the Maxim gun are well enough known without these adventitious aids. If the object really was to try the cuirass, this cannot be said to have been attained. Only two shots were fired at it, and these by Hiram himself, with his own rifle and ammunition. . . . The scene on the ground was not devoid of amusement. The frantic eagerness of the marksmen to fire at the breast-plate, and the desperate discursiveness of its inventor were a curious contrast. . . . We should not have envied the man who was protected by it [the cuirass] since it seemed to transmit the blow to the dummy on which it was suspended, for though the effigy was stayed by a timber prop behind, at about the height of the shoulder, the hat flew off. Neither shot perforated nor dented the back, but as we know nothing about the charge and bullet employed, this does not mean much. . . . Mr. Maxim had certainly broken his word, since he had promised that Mr. Lowe should conduct the trial. The second cuirass was fired at with the English and German service rifles, and resisted the bullets of both, though a three-eighths steel plate which was hung beside it was easily perforated. . . . At this stage the cloth covering incontinently fell off and revealed the steel plate in all its nakedness. Hereupon Mr. Maxim made a speech, attacking Herr Dowe, and German products generally."

That assembly at Erith must have been interesting, from whatever point of view one might regard it.

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The Locomotive.

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A Boiler Explosion on a Tug Boat.

We present, herewith, some particulars of the boiler explosion on the steam tug *Rambler*, which occurred recently while the boat was tied up at Pocket Dock, New Haven, Conn. An hour previous to the explosion the *Rambler* had towed a four-masted schooner down the bay, and she had returned to the dock to meet some friends of Cap-

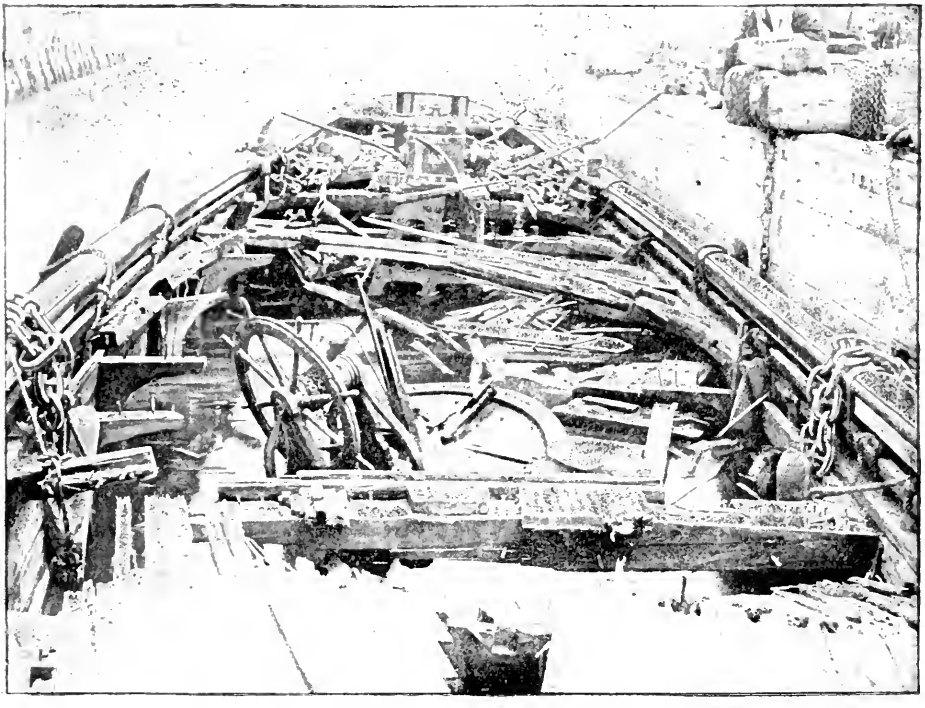

FIG. 1. — THE "RAMBLER" AFTER THE EXPLOSION.

tain Hewitt, who were to go down the bay on a pleasure excursion. Owing to some very fortunate miscalculation the expected party missed a train at Hartford, and were obliged to wait over until after the explosion. Except for this incident they would have been on the boat at the time the boiler blew up, and would undoubtedly have been killed. While awaiting the arrival of the party the captain of the *Rambler* had gone to the office of her owners, and the fireman was away after some paint. About fifteen

minutes before the explosion the engineer of the *Rambler*, Mr. William H. Weimer, went aboard the tug *Thomas J. Walsh*, which was secured to the same dock. The only person remaining on the *Rambler* was Mr. Frederick W. Wells, who was steward, and who, at the time, was frying doughnuts.

The explosion wrecked the *Rambler*, blowing the upper part of her to atoms, some of the fragments being afterwards found at immense distances from the dock where the boat was moored. The hull was not damaged so much, but a hole was opened in it and the vessel sank almost instantly. Fig. 1 shows the appearance of the *Rambler* after

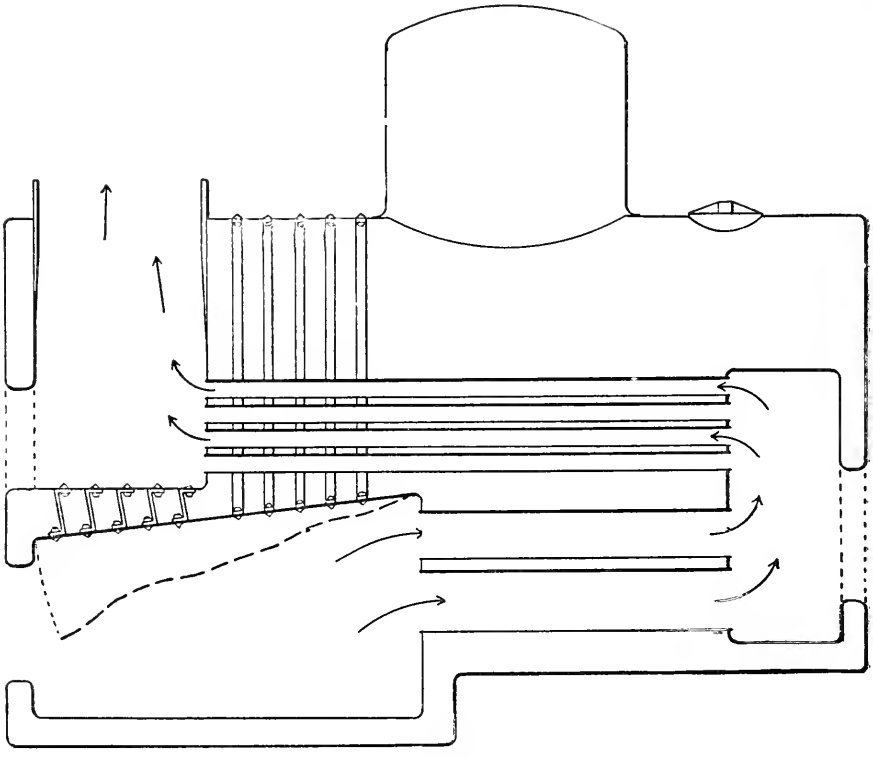

FIG. 2. — SECTIONAL VIEW OF THE "RAMBLER'S" BOILER.

she had been raised from the bottom. Engineer Weimer and Merritt Carney, the assistant engineer of the *Walsh*, were sitting on the deck of that vessel, near the stern. Both men were very seriously scalded about the legs, and Carney was also scalded on the body. They were removed to the hospital. Weimer was blown into the water. Patrick O'Hara, who was unloading railroad ties 150 feet away, was struck in the head by a flying scrap of iron, and a fellow laborer named Harrigan was also injured by a piece of wood. Both of these men will recover, however. The body of the unfortunate steward, Wells, was not found for several days. It was eventually found in the water, near the scene of the explosion. It was found that every bone in his body was broken, although there were no external marks of injury except a slight bruise on his forehead, over the right eye. It is probable that he was killed instantly by the concussion. He was a

genial man, and well thought of by those who knew him. He was a single man, but was to be married in a month or so.

The boiler of the *Rambler* is shown in section in Fig. 2. It contained two furnaces,

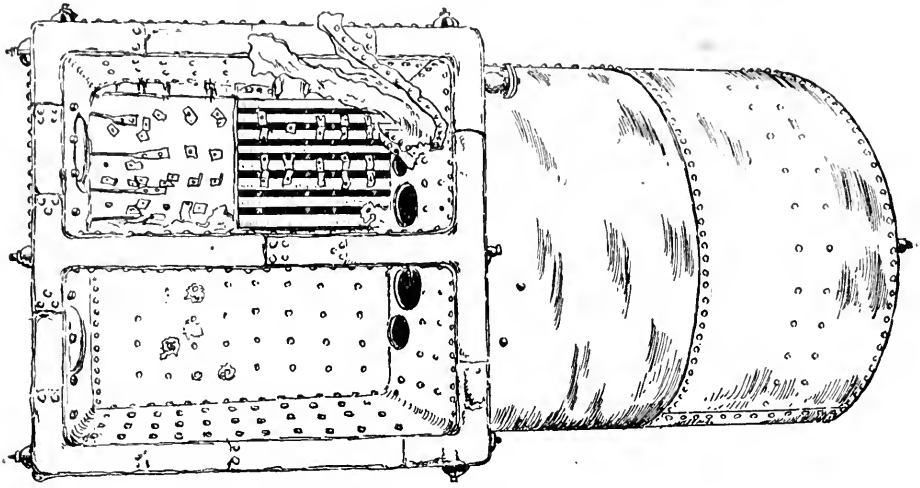

FIG. 3. — THE EXPLODED BOILER, SEEN FROM BELOW.

which were separated by a water-leg. The explosion was caused by the failure of the crown-sheet of the right-hand furnace, as indicated by the heavy dotted line in Fig. 2, and shown in detail in Fig. 3, which is a view of the exploded boiler as seen from below. An examination of the boiler indicates that the explosion was due to improper and defective bracing of the crown-sheets, especially of the one over the starboard furnace. Five of the braces at the right-hand rear corner of this crown-sheet had the appearance of having been broken for a considerable time, and three others had been nearly broken off at some previous time. This left an unbraced area of about 252 square inches. About two feet beyond these, there were three braces which were made straight, $2'' \times \frac{1}{2}''$, with the lower ends riveted to the side or quarter radius of the fire-box crown, and the upper ends twisted through a quarter turn and secured above by pins to two angle irons that were riveted to the wagon-top of the fire-box. Two of these, and one similar brace near the front, appeared to have had no pins before the explosion. The plate first parted at the unbraced area mentioned above, where the braces had been broken previously. The rupture passed across the top of the fire-box to the front, and the front half of the crown-sheet was torn out bodily, and has not been found. Of the

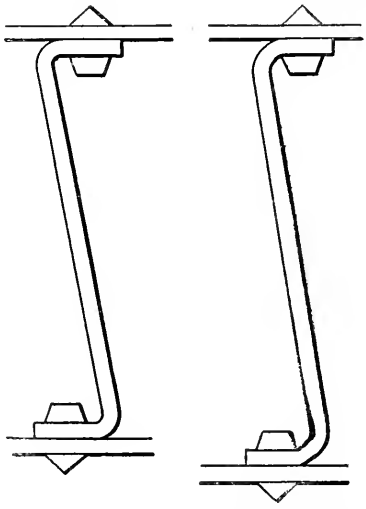

FIG. 4. — ILLUSTRATING THE ACTION OF Z-BRACES.

rear half of the crown-sheet one part turned up, and the remaining portion turned down to the side of the fire-box. There was no indication of low water. The safety-valve was so wedged into the débris that we could not get at it for examination. Engineer Weimer stated that there was plenty of water in the boiler, and that the steam-gauge indicated 80 pounds.

It will be seen from Fig. 2 that flat Z-braces were used on the crown-sheet. This form of brace is inherently weak, and should never be used for such purposes. The solid crow-foot brace is superior to it in every way. In Fig. 4 we present two views of the Z-brace, which will illustrate the cause of its weakness. The left-hand view shows the brace as first put in, while the right-hand view shows what happens to the brace when a pull comes on it. The ends are drawn away from the sheets, and the brace straightens out and allows the crown-sheet to bulge outwards. In most cases this deflection of the crown-sheet will not be sufficient to cause an immediate fracture; but as the pressure in the boiler varies the brace will bend back and forth, and in the course of time it is almost certain to crystallize and fracture across the line of greatest bending. This action is well illustrated by the common process of breaking a wire by repeatedly bending it back and forth with the hands. The action in the case of the Z-brace is precisely the same, and that is why we say that this form of brace is inherently weak.

Inspectors' Report.

MAY, 1894.

During this month our inspectors made 8,142 inspection trips, visited 15,966 boilers, inspected 6,893 both internally and externally, and subjected 735 to hydrostatic pressure. The whole number of defects reported reached 11,613, of which 1,123 were considered dangerous; 35 boilers were regarded unsafe for further use. Our usual summary is given below:

Nature of Defects.	Whole Number.	Dangerous.
Cases of deposit of sediment,	891	45
Cases of incrustation and scale,	2,225	63
Cases of internal grooving,	93	9
Cases of internal corrosion,	698	37
Cases of external corrosion,	873	62
Broken and loose braces and stays,	245	96
Settings defective,	345	37
Furnaces out of shape,	418	18
Fractured plates,	368	73
Burned plates,	203	12
Blistered plates,	286	11
Cases of defective riveting,	1,134	45
Defective heads,	91	16
Serious leakage around tube ends,	1,950	345
Serious leakage at seams,	415	35
Defective water-gauges,	381	58
Defective blow-offs,	168	54
Cases of deficiency of water,	13	6
Safety-valves overloaded,	70	23

Nature of Defects.	Whole Number.	Dangerous.
Safety-valves defective in construction,	76	29
Pressure-gauges defective,	573	38
Boilers without pressure-gauges,	5	5
Unclassified defects,	92	6
Total,	11,613	1,123

Boiler Explosions.

MAY, 1894.

(100.) — A boiler exploded in Compton, near Los Angeles, Cal., on May 1st, instantly killing Alonzo Claus, who was the engineer. C. C. Johnson, who was working near by, was seriously injured about the back and neck, but at last accounts he was not considered to be in immediate danger of death. W. A. Beck also received injuries about the head. The boiler was blown into a hundred pieces.

(101.) — Two large boilers at Robertson & Goodwin's mills, at Williamstown, near Raleigh, N. C., exploded on May 1st. There were fifteen persons in the building at the time, and all of them were injured, ten being caught by the falling timbers. Isaac Bright was dead when his body was reached, and four others were said to be dying. One of the boilers was torn into small fragments, and the other was blown thirty yards from its sitting, part of it going through a steamship warehouse 100 yards away, while other fragments were found three hundred yards from the scene of the explosion.

(102.) — On May 2d a cooking boiler exploded in Mr. G. B. Gehlert's vinegar factory, Bloomington, Ill. The exploded boiler was upright, fourteen feet high, and five feet in diameter. It was used for cooking corn, preparatory to fermenting it for the manufacture of alcohol and acetic acid. It had just been filled with corn, and 55 pounds of steam had been turned on, when, in a few minutes, the explosion occurred. Herbert Crapps, the fireman, was pinned down by timbers, and was enveloped by the escaping steam and boiling water. He was horribly scalded, and it seemed impossible that he could live. At last accounts, however, there was considered to be some slight chance of his recovery. Mr. Joseph T. McCrillis, the distiller, was slightly injured. A heavy section of pipe was thrown 150 feet, and the ground was covered with corn to a considerable distance, some of the grain being found 500 feet away. The building was considerably damaged, the property loss being about $2,000. There was a boiler explosion in this same mill in 1860, by which the engineer was killed.

(103.) — A boiler exploded on May 7th, at Dalton's pickery, Morgan City, La., blowing away the roof and two sides of the building, and setting fire to the ruins. The total loss is estimated at $15,000.

(104.) — In the town of Cyclone, five miles south of Frankfort, Ind., a boiler exploded on May 7th, killing William Spray, the owner of the factory in which the boiler stood. James Durben was also fatally injured, and several other employes received lesser injuries. The factory was completely wrecked.

(105.) — On May 8th, a boiler exploded at the Humphrey Glass Works, in Steubenville, Ohio. The entire west end of the factory was torn down, and the whole interior of the building was wrecked. Mrs. Sarah Smurthwaite's house, adjoining, was also

shattered, and Mrs. Smurthwaite was seriously injured. Her son, Jacob, and her daughter and her baby were badly wounded also.

(106.) — A boiler exploded on May 8th, in the town of New Paltz, N.Y. There was plenty of water in the boiler at the time, and the steam pressure was 60 pounds, although it had been 80 pounds but a short time before. Mr. Ridgeway Lefever had his nose broken, and Harry Enderton was hurt about the back. Another man, whose name we did not learn, was burned about the face. The entire crown sheet of the boiler was torn out, and the building in which it stood was totally wrecked.

(107.) — One of the boilers used to generate steam for the vulcanizing of bicycle tires, in the rubber works at Akron, Ohio, burst on May 14th. The head of the boiler blew out, under a pressure of 45 pounds. Just opposite the exploded boiler is the "wringer-roller" room, and a portion of the brick wall of that room was blown out, and bricks were scattered in all directions. The boiler was a total wreck. There was nobody in either room at the time of the explosion, so that there were no personal injuries nor fatalities.

(108.)— On May 15th, a boiler exploded at the Dorr brickworks, Princeton, Ky. The explosion is said to have been due to the accumulation of sediment on the bottom of the boiler. Nobody was hurt.

(109.) — The boiler of the pump that supplies the Louisville & Nashville Railway tank at Paris, Tenn., exploded on May 16th, completely demolishing the building. Nicholas Purath, who has been in the employ of the company for twenty years, was fearfully scalded, and it is believed that he will die. The boiler was found nearly half a mile from the scene of the explosion.

(110.)— A boiler exploded on May 18th, in F. C. Ross's mill, at West Bay City, Mich. The engineer, George Closson, was killed instantly, and John Scareth was so seriously injured that he will die. Charles Scareth was fearfully bruised about the head and body, but he will probably recover. John Gregg was badly scalded about the face, neck, and right arm, and his hip was dislocated. His condition is serious, but he will recover. William Neal and his son, William Neal, Jr., were injured by flying debris. We have not seen any estimate of the loss on the building, but it is said that the machinery was damaged to the extent of several thousand dollars.

(111.)— A boiler at the Carbondale mine, a few miles southwest of Des Moines, Iowa, exploded on May 21st, injuring the engineer so seriously that he died a few hours later.

(112.)— On May 21st a boiler exploded at Eagle avenue and One Hundred and Fifty-eighth street, New York city. The men were about to begin work in the morning, and just as engineer John Crowley was about to open the stop valve, the fire-box sheets gave way, and the boiler soared into the air like a rocket, and came down through the roof of a stable, 300 feet away. Engineer Crowley and Michael Cannon were seriously injured, and were taken to the Fordham hospital. Each had his left thigh broken, and Crowley was also badly scalded. Patrick Toher, Charles Farrell, and Harry Williams, were cut and bruised, but they were able to go to their homes after their wounds were dressed.

(113.)— The boiler of Harris's mill, near De Funiak Springs, Fla., exploded on May 22d. The fireman, J. H. Davis, was instantly killed. John Cody, one of the mill hands, received injuries about the head that will probably prove fatal, and Henry

Scott's collar-bone was broken, and he was badly scalded and cut about the head. Two other hands received painful scalds and wounds, also. The mill was almost entirely wrecked. The boiler fell some 200 feet away.

(114.)—A boiler explosion that came near being followed by disastrous consequences occurred on May 24th, at the Lehigh and Wilkes Barre mine shaft No. 5, at South Wilkes Barre, Pa. One of the boilers that operated the cages and the fan exploded, leaving some hundreds of miners exposed to the gases below, as well as a party of seventeen or eighteen visitors from the New York Retail Coal Exchange. The incident terminated happily, for the four firemen who were near the exploded boiler escaped with trifling injuries, the workmen below, being familiar with the mine, got out safely, and the seventeen visitors reached the surface of the ground by climbing a thousand-foot ladder. One account gravely remarks that "the party [of visitors] made no further inspection of the coal mines in this vicinity, but returned to the Wyoming Valley Hotel, cleaned up, and took an early train for Scranton."

(115.)—On May 24th a boiler exploded in the East End power house of the Royal Electric company's plant, on Water Street, Montreal. One wall of the building was blown out, and a foreman was slightly injured.

(116.)—By the explosion of a boiler at the Hutchinson, Iowa, electric light plant, on May 25th, three men were instantly killed and one was fatally injured. [This is quoted from the Lansing, Mich., *Democrat*. We presume Hutchinson, Kan., is the town intended.—Ed.]

(117.)—At Sackett's stone quarry, near Ottawa, Canada, a boiler exploded on May 28th. The fireman, J. Beckwith, had three ribs broken and was frightfully scalded. He will die. Homer Sackett, the owner of the quarry, had his legs broken and his body bruised, by flying fragments of the boiler.

(118.)—A heating boiler exploded on May 28th in Lyons & Altingers's barber shop, in Kansas City, Mo. A number of men were present at the time, but all escaped injury.

(119.)—A boiler exploded on May 31st at Henry Lancaster's shingle mill, near the summit of the Santa Cruz mountains, Cal. George Robertshotte of Los Gatos was standing near the boiler when it blew up, and although fragments flew in nearly every direction, and the end of the mill was blown out, Robertshotte escaped injury.

(120.)—On May 31st, a boiler exploded in the Haines mill, at Circleville, Ohio. Joseph Shewler and Sherman Waite were killed outright, Willis Waite had both legs broken, and Samuel Sullivan suffered a fracture of one leg. The injuries of these men are considered very serious, and they may prove fatal. The shock of the explosion was terrific, and the report was heard for miles. A similar explosion occurred near this place a year ago, killing four men.

We have received, from the Lidgerwood Manufacturing Company, of 96 Liberty street, New York, an attractive illustrated pamphlet, or booklet, called *Cableway Sketches*. It is intended to exemplify the application of their cable haulage system to quarrying, mining, lumbering, bridge and dam building, coal handling, and engineering operations of all kinds. The illustrations are very creditable and suggestive. Most of them are from photographs of the actual apparatus.

The Locomotive.

HARTFORD, JULY 15, 1894.

J. M. ALLEN, *Editor.* A. D. RISTEEN, *Associate Editor.*

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Bound volumes one dollar each. (Any volume can be supplied.)

Papers that borrow cuts from us will do us a favor if they will mark them plainly in returning, so that we may give proper credit on our books.

A RECENT boiler explosion at Tarkio has caused a much better attendance at prayer-meetings in that town.— *St. Joseph* (Mo.) *News.*

A SIX-INCH steam pipe burst on May 2d, in the plant of the Southern Electric company, at Philadelphia, Pa. Larry Martin, the night engineer, was scalded and burned so badly that he died almost instantly. John Touhy, a night lineman, was fatally scalded about the face and body, and Fireman John Fife, and Assistant General Manager A. H. Bowen were also painfully but not seriously scalded.

Congressional Ventilation.

By this heading we do not mean the ventilation of ideas, for no one can reasonably doubt that there is a sufficient amount of that. We refer to the supply, not of wind, but of air for breathing purposes. Few persons know of the extensive machinery used for the ventilation of Congress, and we thought the following extract from a recent issue of the Hartford *Times* might be of interest: "For the House of Representatives alone sixteen steam fans are employed, the biggest of them being 16 feet in diameter, and resembling the paddle-wheel of a steamboat. Standing in one of the tunnels in the basement of the Capitol, through which an artificial breeze rushes continually at the rate of twenty-six miles an hour, one feels unpleasantly chilled during the hottest hours of a summer day. When the galleries are crowded every member and spectator in the house is provided with sixty cubic feet of fresh air every minute. In order that the air thus supplied shall contain the proper amount of moisture it is made to pass through stone-lined compartments, where fountains of spray are kept perpetually playing."

AT the request of certain citizens of Gahanna, Ohio, the state inspector of shops for Ohio recently ordered an inspection of the boiler in the Gahanna flouring-mill. We quote the report of the inspector, as given in the Columbus *Press:* "We found over the fire grate quite a bulge, the sheet being sagged down 4 or 5 inches at the bottom of the boiler. In the rear a nipple screwed into the boiler, used as a blow-off, is very much crowded [?] The flues are so coated with lime that the ends are burned off, leaving them loose and thin. The braces in the boiler are loose and not of sufficient strength to support the heads of the boiler under pressure. The front supports of the boiler are

broken, rendering them too weak to support the boiler safely. The glass gauge is small and not reliable, and there are no pop gauges [*i. e.*, try-cocks?]" The report then proceeds to say that the breeching is worn out, that the stock is broken, and that the boiler, on the whole, is in a very unsafe condition, and quite beyond repairs. The report closes as follows: "We consider that you have been extremely fortunate that you have not had an explosion causing great damage and perhaps loss of life, thereby laying yourself liable to heavy damages."

We suppose the owners of this boiler thought it was all right, and that it was still good for years of service. The inspection has no doubt opened their eyes to the facts, and we presume the defective boiler has already been replaced by a new one. Leaving the life question entirely out of consideration, it is a poor financial policy to run a dangerously defective boiler for a single hour.

It would be difficult to convince the average man that fir is a stronger wood than oak, but such has been proved to be the fact by actual tests that were made by a fair and impartial committee appointed for that purpose. The timbers used were each 2 by 4 inches, and four feet long, both ends being solidly braced, and the weight applied in the middle of the span. Yellow fir stood a strain of 3,062 pounds, and common Oregon oak 2,922 pounds. Fine-grained yellow fir from near the butt stood a strain of 3,635 pounds, and best Michigan oak snapped with a strain of only 2,428 pounds. The tests were made by the Northern Pacific Railway Company, at Tacoma, Washington.—*St. Louis Republic.*

Obituary.

Mr. Thomas O. Enders.

It is with profound regret that we announce the death of Mr. Thomas Ostram Enders, who passed away at his home in West Hartford on June 21, 1894. Mr. Enders was born at Glen, N. Y., on September 21, 1832, and in 1854 he removed to Hartford, Conn., where he entered the employ of the Ætna Life Insurance Company as a clerk. Four years later he was elected secretary of that company; and in 1872, upon the death of the Hon. Eliphalet A. Bulkeley, he was elected president, which office he filled with distinction until his voluntary retirement in 1879. In 1881 Mr. Enders was elected president of the United States Bank, in which office he continued until 1892, when failing health compelled him to retire. Owing to his wonderful executive ability, his knowledge of finance, and his sound business judgment, his counsels were earnestly sought by the financial institutions of this city, and for many years he was a director in the Ætna Life Insurance Company, the Ætna Fire Insurance Company, the United States Bank, the Dime Savings Bank, the Society for Savings, and the Charter Oak National Bank. He was also a director in the Hartford Steam Boiler Inspection and Insurance Company, since its earliest days. Mr. Enders was esteemed and honored by all who came in contact with him, and his death is an irreparable loss to the community. At a meeting of the directors of the Hartford Steam Boiler Inspection and Insurance Company held July 2, 1894, it was voted that the following minute be spread upon the records of the company, that it be published in the daily papers, and that a copy be sent to the family of the deceased:

"It is with deep sorrow we record the death of Thomas O. Enders, who has been

connected with this Board for nearly twenty-seven years, having been elected a member July 8, 1867. The company had just entered upon a new and hitherto untried class of insurance, and many doubts were expressed as to its ultimate success. Mr. Enders's faith never wavered. He firmly believed that an enterprise which had sound underlying principles would succeed with well-directed effort and honest management. His wide experience in insurance and financial lines rendered his counsel and advice invaluable. This occasion recalls the early meetings of this board, when methods of management were discussed and the foundations of ultimate success laid. As an associate, Mr. Enders was kindly in his bearing, sympathetic and courteous to all, and his life and character have made an enduring impression upon those who were brought into intimate official relations with him. We record this minute as a tribute to his memory and as a mark of our high esteem for his life and character. C. C. KIMBALL, *Clerk*."

Power Rental.

The following article on this troublesome question is from our esteemed contemporary, *Engineering* (London). In reproducing it we have reduced the items of expense and income to their American equivalents, assuming the English pound equal to $5. Some of the estimates do not correspond with the facts in this country — the wages of the fireman, for example, — but, nevertheless, we think readers of THE LOCOMOTIVE will find the article interesting and suggestive:

"The rental of factories and of power is perhaps not so common now as it was forty years ago, when it frequently obtained, particularly in the Manchester district. Nasmyth relates in his autobiography that he started work on his own account on the upper floor of a mill, the other floors of which were let to separate tenants, and the power for driving the machinery on all the floors was supplied from one engine at a fixed rental. The practice was particularly convenient in the case of a young man going into business on his own account with but a limited capital, but it was not free from objections, as the interests of the different tenants might happen to clash. In fact, this was what occurred in Nasmyth's case, as some of his heavy castings came through the floor one day and smashed up the goods of a glass-cutter, who occupied the floor below. This incident led to a termination of Nasmyth's tenancy, and to the establishment of his well-known works at Patricroft.

"When power is rented in this way, the question arises as to what is a fair price to charge for it. This depends upon several conditions, and a rate which may be perfectly fair for a small amount of power is excessive when greater amounts are taken. At the Chicago Exhibition, where the plant was on the largest scale, steam power was supplied at the rate of $40 per horse-power for the six months during which the Exhibition was open, and electric power at rates varying from $120 to $50 per horse-power, according to the quantity taken. As the plant was a temporary one the fixed charges were naturally high; but as it was also carried out on a large scale, it is probable that these prices paid very well. This case, however, corresponds rather to such a system of power supply as that of the London Hydraulic Power Company, or the Paris compressed air system, than to the rental of the floor of a factory to which the power is supplied from the main engine. This last case has been discussed pretty fully by M. V. Dubreuil in a paper read before La Société Industrielle du Nord de la France. The rate at which power can be rented in such a case will depend mainly upon the rate at which the proprietor

can produce it; for, although a horse-power is of the same value to the tenant whether it be generated by a simple slide-valve non condensing engine or by a compound Corliss engine of the most efficient type, he cannot expect to get it at a cost less than that of production. This cost of production will depend upon the cost of the engine, boilers, and accessories, and on the cost of shafting, etc. For a simple slide-valve engine M. Dubreuil considers that the cost of engine-house foundations, first-motion shafting, piping, and safety-gear, may be taken as 65 per cent. of the cost of the engine; while for compound engines the cost of these accessories will amount to 50 per cent. of that of the engine alone. The cost of the boiler-house, piping, and fittings, may be taken as equal to the cost of the boilers themselves. To these items must be added the cost of external piping, condenser, tanks, chimney, etc., which will add another 20 or 30 per cent. to the combined first cost of engine and boilers. He considers that a fair approximation to the capital cost of engines as erected can thus be arrived at, but there has to be added to this the capital cost of the means of transmitting the power from the engine-house to the machines. In the case of a weaving-shed, M. Dubreuil takes this at from $15 to $20 per loom, and for spinning at from 8 cents to 12 cents per spindle. On all this plant 10 per cent. is not too high an annual rent to demand when the necessity of maintenance is considered. A further capital sum to be considered is the value of the land occupied by the boiler and engine-houses. On this 5 per cent. would be a fair rate of interest, as it is not subject to the same depreciation as the rest of the capital account.

"Hence, if we consider a 100 horse-power simple engine of good type, the capital account will work out about as follows, according to M. Dubreuil (whose prices, however, do not always agree with English experience):

Cost of engine,	$4,000
Cost of foundation, etc. (65 per cent. of $4,000),	2,600
Cost of boilers,	2,400
Cost of boiler-house, piping, etc. (=cost of boilers),	2,400
Accessories (30 per cent. of cost of engine and boilers),	1,920
Transmission gear, say	5,000
Total first cost of plant,	$18,320
Value of the land, say	$800

The annual expenses will then be:

Ten per cent. on $18,320,	$1,832
Five per cent. on $800,	40
Wages of fireman,	325
Sundry stores (oil, etc.),	300
Water,	80
Coal,	1,500
Total annual expense,	$4,077

"The annual cost of 100 horse-power to the proprietor is thus about $4,077, or $40.77 per horse-power; and, including the proprietor's profit, the cost to the tenant should be about $45 per horse-power per annum, as measured at the engine cylinder. M. Dubreuil holds that only about 45 per cent. of this will be received at the machines, so that if the power is measured there, the tenant must pay $100 per effective horse-power per annum, if the owner of the factory is to get a fair return for his risks."

Concerning Inspections and Explosions.

For some reason or other "Constant Reader," "Pro Bono Publico," "Justice," and other correspondents of the daily press whose letters appear in the "People's Column," have recently taken a considerable interest in boiler inspection. Other writers, bolder than these and sometimes fully as aggressive, come out with their true names, and each elucidates the subject of boiler explosions, and also inspections and other cognate matters, from what seems to him to be the right point of view. We do not question in the least the good faith of these gentlemen ; but we believe that their conclusions are usually founded on insufficient data and on imperfect observations. Here is an article, for example, which was recently written for the Albany (N. Y.) *Argus* by Mr. S. W. Snyder :

"Much has been said and written on the causes of boiler explosions and the danger of using an unsafe boiler, or one that has been condemned by an inspector, who too often knows no more about it after an inspection than before, and nine times out of ten he simply takes a hammer and strikes the fire surface plates a few blows, and if any show signs of a dent, then the inspector at once cries out 'dangerous,' when it is just as good (in the hands of a safe man) as a new boiler that has just stood a No. 1 cold water pressure test [!]. There are two, and two only, causes of a boiler explosion, and in order to get up a first-class boiler explosion you must have a first-class strong boiler, and the explosion will deteriorate in the same ratio as the boiler weakens, and if any inspector should say that *any* boiler would be unsafe in the hands of a 'safe man,' I should say that he had better be employed in street sweeping. Now, what are the two causes of a boiler exploding ? The principal cause is letting the water get out of the boiler or below the lower gauge, and then, in order to save his position, the engineer takes his chances and pumps water into the boiler, and this, coming in contact with the red-hot plates of the fire surface, generates a 'gas' that is a hundred times more explosive than giant powder, up goes the boiler and up goes the water-tender with it. The boiler lands near or far, according to its strength, and where the water-tender lands finally depends on the manner of his life. Nine out of every ten boilers 'go up' from this cause. The only other cause of an explosion is carrying too great a pressure of steam, which is as easily avoided, by having a safe man in charge of it, as the other.

"Every boiler, when made, is tested (or should be) by cold water pressure, and this is supposed to be greater than it is subjected to afterwards. Of course, this constant strain upon the boiler weakens it, but *the more the boiler weakens, if tended by a safe man, the less dangerous it is* [!!]. Now, if this be the case, why is it necessary to inspect a boiler ? Well, it is not, unless it is inspected right, and the proper way to do this is as the original inspection was conducted — by cold water pressure — and any inspector well up in his business can tell just how far he can carry the pressure without straining the boiler. When this test is made properly, the inspector should, by law, set the safety-valve and have power to lock the box on the rod of the safety-valve, at least at ten pounds less pressure to the square inch than indicated by the inspection. Register the pressure indicated, and make it a crime for any one to move it. If a lower rate of pressure is needed the water-tender can regulate it by the pump [?], but he can never carry a head of steam above the safe limit. This would make the poorest boiler more than safe.

"The average citizen knows a great deal less about a boiler than he does about his mother-in-law, but is in about the same dread of both. When there is a fearful boiler explosion, causing great loss of life, the boiler traveling from the basement up through

three stories out through the roof, and fragments landing from a quarter to a half-mile from the position it formerly occupied, it is very amusing, when the coroner empanels a jury to view the remains of persons and boiler also, to hear these smart men at once condemn the boiler, saying it was a poor boiler and should not have been allowed to run; whereas, if they had known the least thing about it, they would have known that to make such havoc it must be a good boiler. This shows just how much reliance can be placed upon a verdict from such men as these. A case in point: At five o'clock one summer morning, just as the day shift was going to work at the Tredegar Iron Works, Richmond, Va., a terrible explosion occurred at a paper mill, two blocks away. No sooner had the noise died away than we rushed to the scene, and found that the boiler had left the building in two sections, one going up through the roof and landing in front of the depot, the other having been carried into the heart of the city. Three men and one woman were killed outright. A jury was summoned and did as all juries do in similar cases — condemned the boiler as worthless. The mayor of the city was present at the inquest, and when the verdict was rendered, I said: 'That jury knows nothing about boiler plate. There was no better boiler than that in Richmond yesterday.' I called his attention first to the fact of the great ruin it had caused, saying a poor boiler could never have gotten out of the building, and also directed his attention to the fracture and showed him how loath the boiler was to part, for the fibers or threads were sharp as needles, and then, at my request, the mayor and jury accompanied me to the works, and I cut the condemned plate in strips three inches wide and piled one on the other until I had a three-inch square pile, put it in the furnace and subjected it to a welding heat, rolled it into a half-square and, as one of the jury was a blacksmith, gave him a piece to break, but he found it impossible to do so. A few days after, when the watchman of the building was able to talk a little bit, he said he had gone into the boiler-room, found the water-tender asleep, which, of course, tells the old, old story. When he awoke fully, he tried his gauges, found no water, took the chances, pumped, and up both went.

"Now, what mischief will a very poor boiler do? Well, just none at all. At the Albany iron works in 1866, the boiler connected with No. 2 puddling furnace sprung a leak. The fires were drawn in the furnace and the brick man-holes were knocked in, and it was discovered that a sheet in the center of the boiler and also in the center of the fire surface had cracked, and that the water was leaving the boiler quite rapidly. When the boiler was cooled the man-holes of the boiler itself were removed and a boiler-maker, with a hammer in his hand, entered; and so poor was this boiler that he found no trouble throwing his hammer through any of the plates of the fire surfaces, so thin and rotten had they become. And this boiler was rendered perfectly safe by having a man tend it that knew his business.

"What, then, will render any boiler perfectly safe? Answer: By having a safe, careful man, who knows his business, tend it. S. W. Snyder."

There are some astonishing ideas advanced in this article. What a singular inspector it must have been, who pounded *ad libitum* on the fire sheets, and then looked for dents! If Mr. Snyder had said that *this* man was eminently qualified to be a street sweeper, we should very likely have agreed with him; though it is just possible that we should have held that such a man's true forte is the clam business. Of course it is a truism to say that no boiler could explode when under the care of a "safe man" — a "safe man" being defined as one who can keep it from exploding. The only serious trouble about this is, that when a weak boiler is under consideration there is no such

person living as a "safe man," in Mr. Snyder's sense of the word. Upon this gentleman's theory, we fail to see any reason for having a factor of safety in boilers. Why not make them just strong enough to hold together under the maximum working pressure? Then if they get blown up by these mysterious, irresistible gases and things that Mr. Snyder tells about, there will be the least possible damage done. We understand that, on his theory, such a boiler would be quite as safe, under ordinary running conditions, as a boiler with a factor of safety of 500 or so — provided you could find the hypothetical "safe man" to run it. We thought the low-water theory of explosions was itself exploded, long ago. Of course low water can cause a rupture, by the overheating of the plates and the consequent destruction of their strength; but we thought it had been pretty well established that the energy in a cubic foot of hot water is vastly greater than the energy in a cubic foot of steam at the same temperature, and that when a particularly disastrous explosion occurs, the damage wrought by it is in itself good evidence that there was plenty of water in the boiler. As we have already said, we believe that Mr. Snyder is thoroughly in earnest, and that he honestly believes his teachings; but nevertheless we hold these teachings to be dangerous, because our experience indicates that they are certainly in error.

The following letter, in answer to Mr. Snyder, was sent to the *Argus* a few days after the publication of the one we have quoted:

"In your issue of last Sunday you published an interesting article on 'boiler explosions,' signed 'S. W. Snyder,' and so far as his suggestion of employing 'safe and good men' to have the care of steam boilers goes, I entirely agree with him; but I think he is wrong in some of his conclusions, especially so when he speaks of generating an explosive gas in a boiler. Will he kindly give us the name of the 'gas' so generated? In bygone years my head was filled with the explosive-gas theory, and other kindred causes of boiler explosions, but a study of scientific works on the subject quickly dispelled the illusion. I know that there are a great number of 'practical' men who have a hearty contempt for 'book learning,' but that commodity, coupled with a practical knowledge of mechanics, never did harm to its possessor, in my opinion. But to return to Mr. Snyder's article, I find that he ascribes as a reason for most of the boiler explosions the introduction of water upon hot plates, and I believe that he is in error in this, for I think an explosion most frequently occurs from a structural weakness of the boiler, especially when the latter is in the charge of an incompetent man. Many years ago, one Perkins — a New England man — produced a steam generator in which steam was formed by injecting water on red-hot plates, and not a single one of his generators ever exploded. About thirty years ago, a Reverend Mr. Mitchell of this city patented a revolving steam-generator embodying the same idea, and many of our old citizens had good reason for regretting the fact, but none of his generators were guilty of exploding. To go further back, over fifty years ago the learned Dr. Nott of Union college had a foundry in this city — located near the intersection of Washington and Western avenues of to-day — for manufacturing the celebrated Nott stove, and in the stack of the cupola he placed a water-tube boiler — which, I believe, was the first of a kind that has recently come into vogue — and it was a daily occurrence to have the water get so low in the tubes that they would get red hot, then the engineer would start his feed-pump, and the change of color of the tubes — from red to black — would indicate the level of the water in the boiler, but the boiler never exploded.

"The cause of boiler explosions remains as great a mystery as it was before the Franklin Institute of Philadelphia expended thousands of dollars, appropriated by the

United States government, to investigate such explosions, and were compelled to admit that they could not come to a satisfactory conclusion. WILLIAM H. LOW."

Mr. Low seems to have the right idea in this matter, except in his closing paragraph, where he seems to rescind an opinion expressed in the earlier part of his letter. He says that "the cause of boiler explosions remains as great a mystery as it was . . . ." Now we think that all men who have had large experience with exploded boilers will admit that there is no one CAUSE of boiler explosions. Each explosion has to be considered by itself, and the cause has to be deduced from an examination of the fragments of the boiler, supplemented by such other evidence or testimony as can be had. There are *multitudes* of causes of boiler explosions, and hence it is illogical to try to assign a single cause which should be answerable for all. Moreover, there are extremely few explosions whose causes cannot be found by an experienced man, when he is able to look the facts of the case over within a reasonably short time of the accident.

In closing this article we want to say that Mr. Snyder's method of testing boiler plate is the strangest we ever heard of. We don't know anything about the particular explosion to which he refers, but we cannot see what reason he had for supposing that the quality of the plate remained unaltered after cutting strips, piling them 8 or 10 layers high, raising them to a welding heat, rolling them "into a half square," and cutting them up into lengths. What was the matter with cutting out a strip near the fracture and testing this strip at once, and without further treatment, for tensile strength, ductility, and elastic limit?

IN a paper lately read before the American Society of Naval Architects and Marine Engineers, Mr. George W. Melville, engineer-in-chief of the United States navy, discusses the machinery of some of the latest American war vessels. The difficulty of obtaining a fairly economical engine, both at full power and at cruising speeds, is felt as keenly in the United States marine as in ours [England's]. In Gunboat No. 7 the following plan has been adopted: About two-thirds of the boiler power is obtained from water-tube boilers, which weigh only one-half as much as cylindrical boilers of equal capacity. The engine is designed for quadruplex working at full power, the steam being taken from the water-tube boilers at 250 pounds pressure. The cylindrical boilers, which make up the remaining third of the whole boiler power, are connected by a reducing valve to the first intermediate receiver. At reduced power the large low-pressure cylinders are disconnected, and the remaining cylinders worked as a triple-expansion engine, with steam pressure at 160 pounds per square inch, this steam being furnished by the cylindrical boilers. In the matter of forced draft Mr. Melville prefers to use a closed ash-pit rather than a closed stoke-hold, where this can be conveniently done, which is seldom the case in a war-ship, where a thorough ventilation of the stoke-hold is essential to prevent the atmosphere becoming impure. In the case of the *Brooklyn* and the *Iowa* Mr. Melville wished to get the requisite draft by using funnels 100 feet high, which he claims have several advantages over fan-draft. Within recent years the weights of both engine and boilers, per indicated horse-power, have been substantially reduced; in the latter case by the adoption of coil boilers, and in the former by using higher piston-speeds, and by substituting steel for the wrought and cast iron formerly used. By still further increasing the speed, and possibly by using nickel steel, Mr. Melville thinks that the weights of the engines may be still more diminished in the course of the next few years.— *Engineering* (London).

Incorporated 1866.

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The Locomotive.

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Hand-Hole Guards.

It sometimes happens that a boiler manufacturer who has paid great attention to the more important parts of his boilers, fails to give due consideration to the small things about them that occasionally give trouble. One of these "small things" is the hand-hole guard; and as very little is said about this comparatively insignificant item in the books, we propose to offer a few words of advice about it in the present article.

The simplest form of guard that we know of is shown in Fig. 1; and this form, in our opinion, is also the best one for general use that has yet been proposed. It is often made unnecessarily heavy, but as this does not interfere with its efficiency, one could only object to the extra weight on æsthetical grounds; and it is hardly necessary to say that æsthetics and such mundane things as hand-hole guards have no business with each

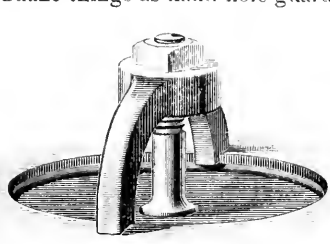

FIG. 1. — COMMON TWO-LEGGED GUARD.

other, anyway. Moreover, it is better to have the guards too heavy than too light, because they will then be less liable to injury from burning.

The only strain that comes on a hand-hole guard is that which is put upon it at the outset in screwing up the nut so as to make the gasket tight. The steam pressure, by compressing the gasket, tends to relieve the strain on the guard, rather than to increase it. So far as strength is concerned, therefore, the two-legged form of guard is quite satisfactory. In days when boilers were made with $\frac{3}{8}$-inch iron heads, and gaskets were much harder than those now in use, it was found that when a two-legged guard was used, the head would sometimes spring enough to cause a slight leakage around those parts of the hand-hole that were furthest from the legs of the guard. A four-legged guard like that shown in Fig. 2 was therefore favored by many builders, and it was held that this form would prevent the plate from springing sensibly. If the four legs rested equally on the head there can be no doubt that this would be the case; but it is readily seen that it is no easy matter to secure this condition. If the head and the guard were carefully planed, or "surfaced," the bearing of the legs could be made practically perfect; but in actual practice we should find, in most cases, that two of the legs took all

the strain, the others being of no particular use. Even if the guard were nicely fitted in one position, the chances are that the first time the fireman took it off he would turn it bottom side up, and then all the careful fitting would become useless. With steel heads, half an inch thick or thereabouts, and with reasonably small hand-holes, there should be no sensible springing of the head with the soft gaskets now in use; and this fact, combined with the extra difficulty of adjusting the hand-hole plate properly when

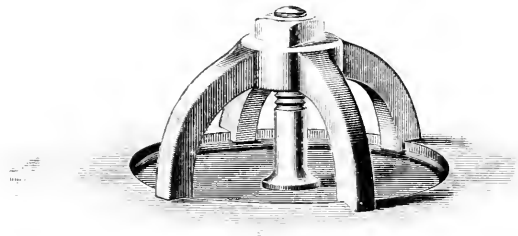

FIG. 2. — ILLUSTRATING THE FOUR-LEGGED FORM.

four-legged guards are used, seems to indicate that in all ordinary cases the two-legged form is quite as good as the quadruped variety.

In Fig. 3 we show a "ring-guard," a form which is now used much less than formerly. This style of guard is particularly objectionable. If there is any leakage around the hand-holes, or any occasional dripping from the tubes overhead, or any condensation of corrosive substances distilled off from the fire, the ring-guard is sure to show at its worst. The moisture or condensible matter from the fire is drawn in between the ring and the head, by capillary attraction, and then the head begins to waste away under the ring, as shown in section in Fig. 4. After a time this destruction of the edges of the hand-hole proceeds so far that the hole has to be cut larger; and if another ring-guard is put on, the same action continues. The time required for the destruction of the edges

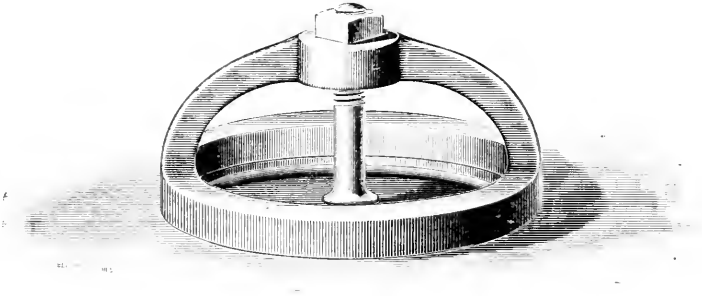

FIG. 3. — THE RING-GUARD.

of a hand-hole in this way will naturally vary with the conditions, with a new boiler it may be three or four years. The wasting does not necessarily take place uniformly in all directions; for if the hand-hole leaks a little, it will be found that the deterioration is most rapid along the lower part of the ring, where the escaped water collects. The hand-hole opening is usually cut as near the flange of the head as possible, for the double purpose of having it a sufficient distance from the tubes, and of having it as near the bottom of the boiler as practicable. It will be readily understood, therefore, that any

further enlargement of the hand-hole along the lower side is apt to make trouble, because as soon as the hole reaches the flange it becomes impossible to make a tight joint without using some special form of plate or gasket; and special forms of plates and gaskets are objectionable, because the fireman, unless he is a pretty good man, is more or less apt to put them in wrongly, thus making matters even worse.

The engraver has shown the ring-guard (Fig. 3) as though there were considerable

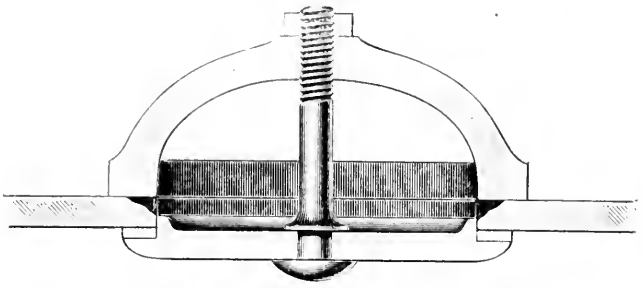

FIG. 4. — ILLUSTRATING THE EFFECTS OF THE RING-GUARD.

space between the ring and the arched rib through which the bolt passes. In practice this space is smaller than shown, and it is not an easy matter to put the hand-hole plate on properly when using a ring-guard, unless one knows the right way to do it. The easiest way, in our opinion, is this: Take a hitch about the bolt with a piece of string, and pass the string through the bolt-hole in the guard. Then put the plate into the boiler and bring it into its proper position. It can now be held by pulling on the string, and the guard can be slipped into position. The nut also can be passed over the string, or the string may be removed and the nut screwed carefully on by hand as far as it will go, the job being finished with the wrench.

If the bolt projects too far beyond the guard it is apt to burn so that the nut cannot be removed, the bolt twisting off before the nut slips on the thread. A preliminary

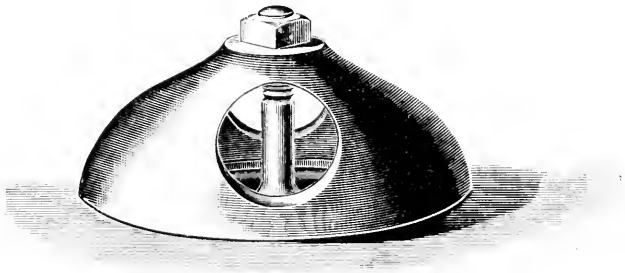

FIG. 5.— THE SHELL-GUARD.

application of kerosene to the nut often greatly facilitates its removal; and it is a good plan, when putting the plate on, to first apply to both bolt and nut a paste made of machine oil and black lead. To protect the projecting end of the bolt it is well to screw on a second nut; it will not matter if this second nut only catches one or two threads, as it is not intended to *hold* anything, its only purpose being to protect the thread of the bolt from the direct action of the fire. Another plan for protecting the

bolt, which is often tried with good results, is to first make quite sure the hand-hole plate is tight, and then to cover up the nut, bolt, guard, and all, with a double handful of fire-clay. This soon bakes on and forms an excellent protective covering. It is readily removed by light blows of the hammer; and as steam or water will disintegrate it, it does not conceal leakages, nor promote corrosion by keeping the head of the boiler damp.

In Fig. 5 we show the old-style "shell-guard," which was probably first designed with the idea of protecting the bolt somewhat from the fire. The protection secured by it is slight, however, and as the objections that we have urged against the ring-guard apply to this form with even greater force, we consider the "shell-guard" to be the least desirable of all the forms shown in the present article.

Inspectors' Report.

JUNE, 1894.

During this month our inspectors made 7,467 inspection trips, visited 13,931 boilers, inspected 6,702 both internally and externally, and subjected 706 to hydrostatic pressure. The whole number of defects reported reached 11,308, of which 976 were considered dangerous; 25 boilers were regarded unsafe for further use. Our usual summary is given below:

Nature of Defects.	Whole Number.	Dangerous.
Cases of deposit of sediment,	840	35
Cases of incrustation and scale,	1,903	101
Cases of internal grooving,	118	12
Cases of internal corrosion,	630	33
Cases of external corrosion,	805	47
Broken and loose braces and stays,	160	25
Settings defective,	373	23
Furnaces out of shape,	487	21
Fractured plates,	273	35
Burned plates,	252	20
Blistered plates,	302	26
Cases of defective riveting,	1,600	29
Defective heads,	105	13
Serious leakage around tube ends,	1,656	356
Serious leakage at seams,	483	13
Defective water-gauges,	388	54
Defective blow-offs,	177	35
Cases of deficiency of water,	16	5
Safety-valves overloaded,	58	23
Safety-valves defective in construction,	67	26
Pressure-gauges defective,	525	38
Boilers without pressure-gauges,	6	6
Unclassified defects,	84	0
Total,	11,308	976

Boiler Explosions.

JUNE, 1894.

(121.)—On June 4th a boiler exploded at the Rankin & Wolfe brick and tile works, Tarkia, Mo. The head of the boiler blew out and passed through a partition and down through the roof of the drying room. The rest of the boiler went in the opposite direction, and finally landed about 250 feet east of the works, striking the ground several times on the way, and incidentally breaking a steel rail into three pieces. The roof of the boiler-house was completely wrecked, and most of it was carried away. The night fireman, Barney Roop, had gone from his accustomed place, out to the north end of the drying room; and this probably saved his life. The chair where he had been sitting was covered with debris. Had the works been in operation and the men in their places at the time of the explosion, several would doubtless have been killed.

(122.)—On June 4th a terrible boiler explosion occurred at an oil well in Montgomery township, near Rising Sun, Ohio. Half of the boiler was carried a distance of 500 feet. The fire-box end was thrown in the opposite direction to about the same distance, passing over a field of oats, and coming down in some woods. In landing, the fire-box felled to the ground one tree that was about 12 inches in diameter, and, rebounding, it damaged another at a height of some fifteen feet. Otto McIntire, the tool-dresser, was thrown 75 feet. He was scalded on the right side and was also badly bruised. He was said to be in a dangerous condition.

(123.)—Smith's drain-tile works, at Wilkinson, near Indianapolis, Ind., were totally destroyed by a boiler explosion on June 5th. Mr. Smith narrowly escaped death.

(124.)—A boiler exploded on June 5th at the Greenleaf-Johnson Company's mill at Howard, Bertie Co., N. C. Two men were killed instantly, and we understand that three more have died since. Four other men were seriously and perhaps fatally injured.

(125.)—On June 6th a boiler exploded on the steam tug *Rambler*, while she was tied up at Pocket Dock, New Haven, Conn. Frederick W. Wells, the steward, was killed instantly. William H. Weimer and Merritt Carney, who were on the neighboring tug *Thomas J. Walsh*, were painfully injured. The upper part of the *Rambler* was demolished, and a hole was opened in the hull, so that she sank almost instantly. Engineer Weimer is reported to have said that "the explosion was due to an undue generation of gas." We think the true cause was correctly stated in the July issue of THE LOCOMOTIVE, where this explosion was illustrated and described.

(126.)—A hot-water heater exploded on June 6th in a chair-car on an east-bound through train of the Chicago, Burlington & Quincy Railroad. Harvey Wright, a porter, was seriously injured, and it was said, at first, that a dozen passengers received slight injuries, though this was afterwards denied by the railroad officials. The accident occurred on the high bridge crossing Bureau river, one mile west of Princeton, Ill. The explosion was due to the corrosion and consequent sticking of the safety-valve.

(127.)—Two buildings, sixty feet long and thirty feet wide, were destroyed on June 8th by the explosion of a coil of steam pipe used in the soap factory at the insane asylum in Kankakee, Ill. The engineer and fireman narrowly escaped death.

(128.)—A terrific boiler explosion occurred on June 8th at Choptank, near Denton, Md., in Jesse A. Wright's shirt factory. The account says that "J. A. Wright, the

proprietor, Will Towers, the engineer, and A. L. Dunham and John K. Watson, employes, were engaged in repairing the machinery before the regular work of the day began. The engine had been stopped and the attention of the men was entirely occupied by the work in hand. The rising steam in the boiler was forgotten, and considerable time passed before anybody looked at the gauge. The discovery was then made that instead of 85 pounds, the pressure had gone beyond the 140-pound mark. Almost instantly the crash came. The engine-house, which adjoins the factory, disappeared, and the cloud of roaring steam was pierced by flying iron and timber. Big pieces of the boiler were blown far into the river beyond the long piers, and part of the factory proper was wrecked. Mr. Wright and Mr. Towers were very seriously injured. The former was crushed about the legs, and amputation will probably be necessary. Mr. Towers was knocked down and mangled, and Messrs. Dunham and Watson were badly scalded. One woman in the factory was hurt. Mr. Wright's loss is heavy. The engineer will probably die."

(129.)—On June 12th a tube burst in one of the water-tube boilers at the Edison Electric Light Company's plant, in Columbus, Ohio. Nelson Secrist, a fireman, was stooping before the boiler at the time, pulling out ashes. The explosion blew the furnace door open, and Secrist was badly burned and scalded.

(130.)—A boiler exploded on June 12th in a mill near Linneus, Mo. The body of James Logue, a workman, was torn to fragments, and Aaron Logue was cut in twain. Michael Logue was blown into a tree-top, and every bone in his body was broken. William Kemper was also blown some distance and fatally injured. Pieces of machinery were driven several inches into trees, and the mill fixtures were scattered over a large area. A few months ago there was a similar explosion at this same mill.

(131.)—The boiler in Gossler & Co.'s mill at Deloys, near Cammal, Pa., exploded on June 13th, instantly killing the fireman and his little daughter. The boiler was blown into a creek about 75 feet away.

(132.)—On June 13th the head blew out of a boiler at the Oneida Carriage Works, at Oneida, N. Y. We have not learned the amount of the damage, but it was said that the works would have to lie idle at least a month. It appears that nobody was injured.

(133.)—A boiler belonging to W. H. Brown & Sons, at Elrod, Pa., exploded on June 16th, wrecking the building in which it stood. The accident occurred at the noon hour, while the men were at dinner, and nobody was hurt. Fragments of machinery were blown through the office.

(134.)—A kitchen boiler exploded on June 17th in the residence of F. G. Platt, on Grove Hill, New Britain, Conn. The stove was "blown into a thousand pieces," and the house was considerably damaged. Fortunately there was nobody in the kitchen at the time.

(135.)—On June 18th a boiler exploded in Bilger Bros.' saw-mill, on the side of Nittany mountain, just south of Pleasant Gap, Pa. Nelson E. Bilger, the engineer, was blown through a board wall, and his body fell in a mud-hole fifty feet away. He was killed instantly and horribly mangled. In fact, one account states that "not enough of it could be found for the coroner to hold an inquest on"; but that is not true. Herbert Bilger was badly scalded and bruised, but will recover. The boiler parted in the middle, one end of it flying 300 feet in one direction, while the other flew 200 feet in the opposite direction. The mill was blown to pieces. Eight workmen had just left the mill for the

mountains, so that if the explosion had occurred a few minutes earlier the list of fatalities would have been more extensive.

(136.) — Two boilers exploded on June 19th at the Wells Roller Mills, Wells, Minn. Engineer George Baer was killed instantly, and the property loss is about $5,000 or $6,000. The mill is owned by W. H. Ketzlback & Co.

(137.) — On June 20th a locomotive boiler exploded at Hiawassa Station, Tenn., on the Marietta & North Georgia Railroad. Fireman James Devers was instantly killed. J. C. Devers, engineer, J. C. Sanger, baggage-master, and A. D. Bentley, brakeman, were badly hurt, Sanger fatally so. The accident occurred at the foot of a mountain, where the large pushing-engine, of which J. C. Devers was engineer, hitched on a south-bound train to pull it over the mountain. The engineer of the train had detached his engine and gone over the mountain, and young Devers had come off the siding and backed the pushing-engine up to the train. Bentley and the elder Devers were on the ground making the coupling, and Sanger was in the baggage-car. Young Devers was hurled into this car, the front end of which was torn away by the explosion, and without doubt he was killed instantly. Sanger was fearfully scalded, so that he died next day. The elder Devers was considered to be fatally injured, but at last accounts he was still living. It is said that one of the sheets of the exploded boiler was known to be cracked.

(138.) — By a boiler explosion that occurred on June 21st near Louisa, twenty-five miles from Ashland, Ky., Robert Jones was instantly killed, and his father, Jacob Jones, was fatally injured. The building in which the boiler stood was completely wrecked.

(139.) — By the explosion of a boiler at Cottondale, near Pensacola, Fla., on June 22d, Mr. H. H. Ratliff was fatally injured, so that he died in a few hours. The fireman, who was also near the boiler, was dangerously injured, but it is believed that he will recover.

(140.) — On June 27th a head blew out of one of the boilers in the Wilkeson Elevator, in Buffalo, N. Y. Chief Engineer Robert Whalen was struck by a piece of iron, and was also scalded. He will recover, however. We have not learned the extent of the property damage.

(141.) — A boiler exploded on June 28th in Stevenson's mill at Cayuga, Ont. Engineer John Commer was killed instantly, and a workman named Franks was injured so badly that he died on the following day. William Stevenson, Jr., was badly scalded about the face, and Frank Lathrum was also scalded, but not so seriously. The mill was completely wrecked, and the boiler was thrown 200 feet.

On August 2d, according to the *Scientific American*, a tack dropped into a picker machine in a four-story mill in Philadelphia, causing a $70,000 fire, in the course of which two firemen were killed and seven injured by a falling floor. The tack caused a multitude of sparks to fly out of the picker, and these ignited the inflammable yarn into which they fell and started a blaze that spread through the room very quickly.

The Locomotive.

HARTFORD, AUGUST 15, 1894.

J. M. ALLEN, *Editor.* A. D. RISTEEN, *Associate Editor.*

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Papers that borrow cuts from us will do us a favor if they will mark them plainly in returning, so that we may give proper credit on our books.

ACCORDING to the London *Times*, Mr. Hiram Maxim has been partially successful in his attempt to construct a practical flying machine. He and two others have traveled some 500 feet with it. It remains to be seen whether the machine possesses the necessary stability, and whether or not it satisfies the other requisites of a practical aerial vehicle.

WE have received the *Report* for 1893 of the National Boiler and General Insurance Company, limited, of Manchester, England. It contains a variety of interesting matter relating to boilers and boiler explosions. Readers of THE LOCOMOTIVE will be pleased to learn that the National Company has found the form of butt-strap joint that the Hartford Steam Boiler Inspection and Insurance Company has long advocated, to work very satisfactorily. (For details of this joint see Fig. 5 in President Allen's Corneli lecture, as reprinted in THE LOCOMOTIVE for July, 1891.) The butt-strap joint in common use in England for high-pressure Lancashire boilers has the outer and inner straps of equal width; and this makes it difficult to do a good job of calking. In the Hartford joint the outer strap is narrower than the inner one, and the calking-edge, between successive rivets, is only half as long as in the usual Lancashire butt-joint.

The Resurrection of an Old Friend.

Another scientific magazine has appeared. It is called *The New Science Review*, and, according to the title-page, it will be published quarterly. In the first number we note with interest an article by Mrs. Bloomfield Moore, entitled *A Newton of the Mind*—rather a high-sounding title, considering that the Newton referred to is none other than the celebrated John Ernst Worrell Keely, the unspeakable, imperishable, perennial Keely, of motor fame. It appears that he is at last on the high road to success. All the obstacles that have hitherto baulked him and made his life one dreary stretch of misery and ache have dissolved away; he has finally laid bare the heart of nature, so that he can stick a pin through it and preserve it for future reference.

> He comes from Table Mountain, and his name is Truthful James;
> He is not up to small deceit, nor any sinful games;
> But he'll tell in simple language what he knows about the how
> Of the going of the motor that has never gone till now.

Let us therefore sit reverently at his feet and drink in the honeyed words of wisdom as they drop from his lips. "Physicists," he says, "have been working in the wrong

direction to lead them to associate with Nature's sympathetic evolutions. It is not necessary to advance further into the unexplored region of these sympathetic flows than the ninths, to become convinced that the one I denominate the dominant is the leader toward which the remaining thirds of the triune combination (of triple sympathetic streams) co-ordinate, whether it be the cerebellic, gravital, or magnetic. When we reach the luminiferous track on the ninths, in the triple subdivision, we have proof that the infinite stream, from that unexplored region where all sympathetic streams emanate, is triune in its character, having the dominant as the sympathetic leader, to which the remainder of the celestial thirds are subservient." And again, "The nearer the approach to the neutral centers, when the dissociation takes place, the greater is the latent force evolved. In molecular dissociation the instrument is set on the thirds, meeting with a rotating resistance of five thousand pounds per square inch, without any interference with the inter-molecular position. . . . To reach the atomic centers the instrument is set on the ninths dominant, the sixths harmonic, and the thirds enharmonic, having the transmittive chord *B* associated with each. At this setting the corpuscular percussion exceeds twenty-five thousand pounds per square inch. The subservience to the co-ordinate sympathy is shown in the result by a pressure exceeding fifteen thousand pounds, reaching, in this subdivision, almost as near the neutrals as instruments can carry us. The atomic and inter-atomic settings constitute the introductory conditions governing the nodal outreach as toward the etheric. . . . The region of the inaudible is reached — the introductory etheric and the first features of the invisible latent force existing in corpuscular embrace have been handled."

Bravo, Keely! Spencer doubtless had you in mind when he cried, "Witness the pomposity of sesquipedalian verbiage!" The trouble with you, Keely, is that your language is mere words — it doesn't mean a single, solitary, most microscopic thing. We don't know whether you are crazy, or what is the matter with you; but we honestly think it is time for you to call in your family doctor.

Cheap Boiler Insurance is Dangerous.

We clip the following interesting article from our bright, artistic, and ably-edited contemporary, *Cassier's Magazine*. It is well-worth reading, and should be suggestive to boiler-owners:

The danger of employing unqualified boiler inspectors was recently well exemplified in a small English town by a boiler explosion which did considerable damage to property in the immediate neighborhood of the scene of action. The boiler in question, it would seem, had gone the way that many boilers unfortunately do go, after having served nearly the full period of their usefulness, from its last place of fairly safe operation to the paint shop of a second-hand dealer, from which it emerged spick and span, ready to be sold again to some one unacquainted with its history and eager for a bargain. Paint has a wonderfully rejuvenating power over boilers as well as some other things, and with the help of an unprincipled inspector's certificate, soon had this boiler again at work, with the result, before long, of a wrecked boiler-house, damaged buildings adjoining, though, happily, no loss of life, and a bill for the owner for the costs of the usual investigation by the local authorities. The payment of the costs was exacted "as a warning to other steam-users who rely upon unqualified, incompetent inspection, because it is cheap, and afterwards plead ignorance as an excuse for their conduct."

The episode pointedly directs attention once more to the subject of cheap boiler inspection and insurance, which off and on has been condemned for many years, though

evidently not with sufficient vigor to have brought about its suppression. Cheap inspection and insurance rates, in fact, seem to possess an allurement to many boiler owners which is quite surprising, when even slight consideration will show that cheap service of any kind in connection with boilers is simply not worth having. It cannot be profitable, but certainly will prove dangerous. England, more than any other country, has suffered from a multiplicity of boiler inspection and insurance companies, and with growing competition among these, and failure on the part of steam-users to properly appreciate the value of thorough and conscientious examination of their boilers, decrease in price and corresponding decrease in the reliability of the service rendered have become natural and unavoidable results. There is a price, as has often been argued, below which a guarantee of faithful inspection cannot possibly be extended without seriously affecting the financial stability of any insurance company. A close approximation to what this price is could probably be made in most cases without much difficulty, and any offer of insurance and inspection at a much lower rate should be regarded with suspicion. In the United States, if not elsewhere, the truth of this seems to have been thoroughly realized. Boiler inspection and insurance competition are there at a minimum. The work is practically all in the hands of one company, and for a long term of years has been carried on in a painstaking, thorough manner, which has demonstrated its merits beyond all question.

Hunting For Lost Manuscripts.

The recent order of the Czar to search the subterranean halls and rooms of the great Kremlin, at Moscow, for hidden treasures, has aroused interest, not only in Russia but throughout the civilized world. The prime reason for the order is the belief that in some far away cell is hidden the famous library of Ivan IV, surnamed the Terrible. Ivan IV was the Louis XI of Russia. It is known that the famous ruler devoted the little leisure left him by war and politics to collecting Greek and Latin manuscripts, and it is believed that more than eight hundred of these precious documents are concealed in some underground cavern of the palace in which he passed much of his time. Most of these manuscripts, according to Russian scholars, upon whose recommendation the Czar has acted, are unknown to the Occidental world, and may change many of the accepted Greek and Latin traditions. The result of the tour of discovery is therefore awaited with deep interest, not only by Russian savants, but by scholars all over the world.

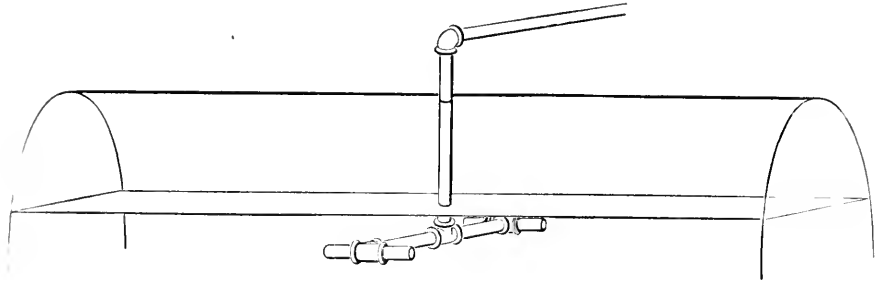
Many other things of value — intrinsic and historical — may be brought to light by the search in these caverns. The Kremlin is the most important building in all Russia. The name alone exercises even to-day a mysterious influence over every son and daughter of the golden-domed country. It is the monument of the glory — and misery — of Russia. Its history is the history of modern Russia. It has been devastated by the Tartars, it has been burned by the Poles, it has been occupied by Napoleon. It saw Peter the Great grow to manhood, it saw the fall of Boris Godounof and the False Dimitri. It has been spotted by the blood of the innocent and stained with the blood of the guilty. But with all its history, it inspires a Russian to-day with feelings to which words can give no adequate expression.

In the dark caverns are supposed to be not only manuscripts of Cicero, Cæsar, Tacitus, and the Greek writers, but documents relating to the history of Russia, testaments of ancient Russian princes, and papers left by the Mongolian Khans who once held sway within its walls. Russian writers of the seventeenth century mention the library of Ivan

IV, and say that the subterranean vaults contain other, almost countless, treasures, hidden by the Czars and princes in times of war and invasion. The only fear is that the manuscripts have been destroyed by the bookworm, the dampness natural to the depths in which they are supposed to be, or the effects of time. Weeks or even months may go by before the search is ended; but Alexander III will deserve and receive the thanks of all students for undertaking a work which Czars before him declined to do. — *New York Tribune.*

The Strains Produced by Feed-Water.

A correspondent writes as follows: "In the May issue of THE LOCOMOTIVE, I find an article on 'The Chilling Action of Feed-Water,' which I have read with interest. I send you some notes of a similar case which came under my notice recently, and which goes to prove the truth of the article mentioned. A manufacturer of knit-goods had in use a medium sized steel boiler, which was first-class in every respect, so far as material and workmanship were concerned. The feed-pipe was connected on the lower part of the

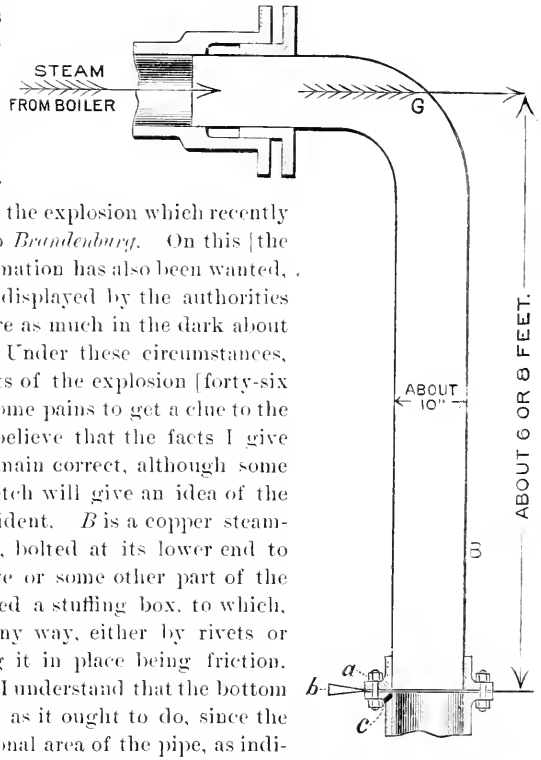


boiler, and the feed-water entered the boiler at a temperature of about 200° Fah. A leakage was discovered at the bottom of the shell where two of the plates came together, and by putting a piece on (and in other ways also) they tried to remedy the defect, but failed to do so, the shell continuing to leak in spite of every effort to stop it. An inspector was called in to look into the matter. He located the cause of the trouble and said, 'The feed-water is chilling the shell of your boiler.' Following his advice, the feed-pipe was changed so as to enter from the top, and it was then carried down till it dipped just below the water-level. Instead of allowing the pipe to discharge directly, a double L connection was attached to it, so that the feed water was in a measure distributed to different parts of the boiler. Since this change was made, no trouble from leakage has been experienced. I send a rough sketch to illustrate the final arrangement of the feed-pipe."

Without doubt many of the leakages that occur along the girth-joints of steam-boilers are due to the chilling action of feed-water. In preparing the article cited by our correspondent, however, we had no idea of claiming to have made a new discovery. This action of feed-water has long been known, and we have called attention to it many times in the past. The article in question was intended to be merely a *popular demonstration* of the importance of locating feed-pipes correctly. Nevertheless, we thank our correspondent for his courtesy in providing us with further confirmation of it.

The Explosion on the "Brandenburg."

In the February issue of THE LOCOMOTIVE, we gave a brief account of the terrible explosion that occurred on the German cruiser *Brandenburg* on February 16th. The details of the accident were suppressed, and all particulars which might be interesting from an engineering standpoint were withheld, and the whole affair has been surrounded with mystery ever since. These circumstances have naturally led to the belief that the disaster was due to some piece of stupidity or negligence, which the German officials were ashamed to divulge. A correspondent of London *Engineering*, writing from Berlin and signing himself "An English Engineer in Germany," now gives the following particulars of the accident:



"Your correspondent '*R. N.*', whose letter of inquiry appears on page 860 of your issue of June 29th last, is not alone in his desire for information respecting the cause of the explosion which recently took place on the German warship *Brandenburg*. On this [the German] side of the Channel information has also been wanted, but so much reticence has been displayed by the authorities that German engineers generally are as much in the dark about the matter as those in England. Under these circumstances, and in view of the disastrous results of the explosion [forty-six men were killed], I have been at some pains to get a clue to the jealously guarded mystery, and I believe that the facts I give below will be found to be in the main correct, although some details may be wanting. The sketch will give an idea of the arrangement which led to the accident. *B* is a copper steam-pipe about ten inches in diameter, bolted at its lower end to the cast-iron flange of a stop valve or some other part of the engine, while its upper end entered a stuffing box, to which, however, it was not secured in any way, either by rivets or otherwise; the only force holding it in place being friction.

"When steam was gotten up, I understand that the bottom joint began to leak on the side *a*, as it ought to do, since the steam pressure, acting on the sectional area of the pipe, as indicated at *G*, had a leverage of some six or eight feet. Then, I am told, some one drove in a thin wedge at *b*, to try and stop the leak (!). The cast-iron flange next parted from its body at the black line marked *c*, and as there was then nothing to hold the pipe *B* in place, it was simply blown out of the stuffing-box, providing a free escape for the steam, with the consequences we all know. It is certainly difficult to understand how such an arrangement as I have described came to be carried out. Perhaps the publication of this letter may lead to further information being forthcoming."

There is a certain air of genuineness and truthfulness about this letter; and if the explanation here given is indeed correct, we do not wonder that the German officials strove so hard to hush the matter up. When an accident of this sort happens in America, it is the proper thing for foreigners to talk a good deal with their mouths about the flimsiness of our methods of construction.

The Development of the Sleeping Car.

In 1859 Mr. Pullman went out to Chicago to take a contract for the leveling of the streets, and the same year he hired a shop, employing a master mechanic and a number of workmen, and turned out his first sleeping car, which was run over the Chicago & Alton Railroad. It was the first sixteen-wheel car ever built, and was called the *Pioneer*. It is still preserved at the company's works in Pullman, Ill. It was larger than the ordinary coaches, and practically decided the size and form of the Pullman cars that succeeded it, only the length having been increased. Until 1864 the form of car now in use, which is as available during the daytime as at night, had never been thought of, the *Pioneer* having been built with the idea of using it only as a sleeping car. Abraham Lincoln is said to have been one of the earliest passengers on the *Pioneer*, and his body was taken from Chicago to Springfield on this car. It was so much higher than any of its predecessors it could not pass under some of the bridges. They were removed by the railroad companies, however, when the trip was made with President Lincoln's body. Later General Grant made a trip West in the car.

The *Pioneer* attracted so much attention that Mr. James F. Jay, President of the Michigan Central road, decided to try some of the cars on his line, and four were built for the purpose. They proved even more expensive than the *Pioneer*, which had cost $18,000, the average price of sleeping cars before that time having been less than a fourth of that sum. But the new cars cost $24,000 each. It was found that it would not be possible to rent a berth in one of them for the old price of $1.50, so it was decided that the berths in the new cars should cost $2. This was against the vigorous protest of the president of the road, who agreed to the advance only when Mr. Pullman suggested that the public be allowed to decide which it would patronize. So the new Pullman cars with berths at $2 each were run on trains side by side with the old-fashioned sleepers charging fifty cents less. The old cars were soon taken off the road, as nobody would use them. At present there are in use throughout the country 2,573 Pullman cars, of which 650 are buffet cars and 58 are dining cars. During 1892 the number of miles the cars traveled were 204,453,796, and 5,673,129 passengers were carried. About 9,000 meals a day are eaten in the dining and buffet cars, and 33,000,000 pieces of Pullman car linen are laundered annually.

Theodore T. Woodruff is said to have done almost as much for the improvement of the sleeping car as Pullman. Woodruff prepared his model in the office of James Tillinghast at Rome, N. Y., in 1854. Tillinghast, who was at that time in the employ of the Rome & Watertown Railroad, lacked sufficient faith in Woodruff's scheme to advance the money necessary to have it patented. Woodruff finally found a patron in a car-builder at Springfield, Mass., who built a trial car, which made its first trip on the New York Central and the Rome & Watertown Railroad. The car was afterwards run to Cleveland and other Western cities, finally becoming the property of the Ohio & Mississippi Railroad, which ran the car on its line for several years. Woodruff afterwards sold the right to build and use his cars on certain roads to Webster Wagner, and the rights of his patent on the Buffalo & Erie road were sold to George Gates. Gates operated independently until 1873, when he sold out to the Wagner Palace Car Company.

Wagner, who built all the cars for the Vanderbilt roads, was born of German parents, near Palatine Bridge, N. Y. He had learned the trade of a wagon maker as a young man. He accumulated a large fortune, and became a State Senator. He was killed on one of his cars in an accident at Spuyten Duyvil in 1882. — *New York Sun.*

On Wire Gauges.

There is hardly anything in the mechanical arts so confusing as the methods now in use by the various manufacturers for designating the sizes of wire. Almost every one of these manufacturers has his own peculiar system for numbering the wire he turns out, and the result is that "No. 24" means nothing at all unless the "gauge" is also specified. Thus, No. 24 wire is .0201″ in diameter according to Brown & Sharp's gauge, .022″ according to the Birmingham gauge, .023″ according to Washburn & Moen, .0225″ according to the Trenton Iron Company, .0231″ according to G. W. Prentiss, and .025″ according to the old English scale. In some other sizes, the differences are even greater. Thus, No. 000 is .3586″ in diameter according to Prentiss's gauge, and .425″ in diameter according to the Birmingham gauge — a difference of .0664″, or more than $\frac{1}{16}$ of an inch.

To obviate this confusion, Messrs. Brown & Sharp proposed their "American Gauge," which has been adopted by the brass makers. It has also been favorably received by the principal drawers of other kinds of wire, although it has not yet been universally adopted by them. The sizes of Messrs. Brown & Sharp's scale progress in a geometrical ratio, the diameter of any size on this scale being found by multiplying the diameter of the next larger size by 0.890525. This rather clumsy ratio was chosen in order to make the new gauge agree as well as possible with the older, arbitrary gauges; for these had been in use so long that it was not likely that a new gauge would be generally adopted if it differed from the old ones radically. In the accompanying table we give the diameters of wire according to the "American gauge," and also, for comparison, the diameters of the corresponding sizes on the principal other gauges in use in this country, as quoted by Brown & Sharp.

The best way to order wire is by stating the desired diameter in decimals of an inch. This avoids all chance of misunderstanding, and assures the customer of getting what he wants. Some of the difficulties that arise from specifying the "number" of wire are thus set forth in a circular issued by Messrs. Miller, Metcalf & Parkin, and quoted by Brown & Sharp. "Another trouble is with the wearing of the gauges, for which there is no remedy; and we imagine that no man ever throws away a gauge because it is worn out. On the contrary, it represents an outlay of six dollars; he is used to it, he measures everything by it, and he is mad when anything does not measure to suit it. A still more serious difficulty arises from a very common mode of ordering. We frequently have orders for such a gauge, 'light' or 'tight', 'full' or 'scant', 'heavy' or 'easy'— terms which are perfectly ambiguous. Again, the order may be for such a number and one-half — for instance, 15½. This latter kind of order is extremely confusing to a roller, for he almost always takes it to mean that the wire is to be thicker than the whole number, and is pretty sure to make 14½ for 15½ if he is not warned beforehand. How is it possible for a roller to know just how many millionths of an inch another man, whom he never saw, means, when he says No. 28 'full', or No. 27 'easy'? And how is he to guess how many thousandths of an inch the other man's gauge is wrong in its make, or how many hundredths it has worn in years of steady use? This is no fancy sketch, for the difficulties we have referred to arise every day in this age when every man knows just what he wants and will have nothing else, and yet has no better way of telling his wants than to say he wants such a gauge 'tight', when probably his gauge differs from every other gauge that was ever made. There is a very easy and simple way out of this whole snarl, and that is to abandon fixed gauges and numbers altogether. We cannot now recall a single case of serious complaint having arisen where we have had the desired size of wire specified in decimals of an inch."

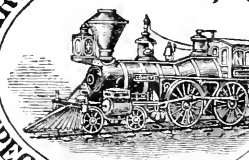
Standard Wire Gauges in Use in the United States.

(The diameters are given in decimal parts of an inch.)

Number of Wire Gauge.	American, or Brown & Sharp.	Birmingham, or Stubs'.	Washburn & Moen Mfg. Co.	Trenton Iron Co., Trenton, N. J.	G. W. Prentiss, Holyoke, Mass.	Old English, from Brass Mfrs. List.	Number of Wire Gauge.
000000	.....	.....	.460	.....	.....	.....	000000
00000	.....	.....	.430	.450	.....	.....	00000
0000	.46	.454	.393	.400	.....	.....	0000
000	.4096	.425	.362	.360	.3586	.....	000
00	.3648	.380	.331	.330	.3282	.....	00
0	.3249	.340	.307	.305	.2994	.....	0
1	.2893	.300	.283	.285	.2777	.....	1
2	.2576	.284	.263	.265	.2591	.....	2
3	.2294	.259	.244	.245	.2401	.....	3
4	.2043	.238	.225	.225	.2230	.....	4
5	.1819	.220	.207	.205	.2047	.....	5
6	.1620	.203	.192	.190	.1885	.....	6
7	.1443	.180	.177	.175	.1758	.....	7
8	.1285	.165	.162	.160	.1605	.....	8
9	.1144	.148	.148	.145	.1471	.....	9
10	.1019	.134	.135	.130	.1351	.....	10
11	.0907	.120	.120	.1175	.1205	.....	11
12	.0808	.109	.105	.105	.1065	.....	12
13	.0720	.095	.092	.0925	.0928	.....	13
14	.0641	.083	.080	.080	.0816	.083	14
15	.05707	.072	.072	.070	.0726	.072	15
16	.05082	.065	.063	.061	.0627	.065	16
17	.04526	.058	.054	.0525	.0546	.058	17
18	.04030	.049	.047	.045	.0478	.049	18
19	.03589	.042	.041	.040	.0411	.040	19
20	.03196	.035	.035	.035	.0351	.035	20
21	.02846	.032	.032	.031	.0321	.0315	21
22	.02535	.028	.028	.028	.0290	.0295	22
23	.02257	.025	.025	.025	.0261	.0270	23
24	.02010	.022	.023	.0225	0231	.0250	24
25	.01790	.020	.020	.020	.0212	.0230	25
26	.01594	.018	.018	.018	.0194	.0205	26
27	.01420	.016	.017	.017	.0182	.01875	27
28	.01264	.014	.016	.016	.0170	.0165	28
29	.01126	.013	.015	.015	.0163	.0155	29
30	.01002	.012	.014	.014	.0156	.01375	30
31	.00893	.010	.0135	.013	.0146	.01225	31
32	.00795	.009	.0130	.012	.0136	.01125	32
33	.00708	.008	.0110	.011	.0130	.01025	33
34	.00630	.007	.0100	.010	.0118	.0095	34
35	.00561	.005	.0095	.0095	.0109	.0090	35
36	.00500	.004	.0090	.0090	.0100	.0075	36
37	.00445	.....	.0085	.0085	.0095	.0065	37
38	.00396	.....	.0080	.0080	.0090	.00575	38
39	.00353	.....	.0075	.0075	.0083	.0050	39
40	.00314	.....	.0070	.0070	.0078	.0045	40

Incorporated 1866.

HARTFORD STEAM BOILER INSPECTION AND INSURANCE CO. HARTFORD, CONN.



Charter Perpetual.

Issues Policies of Insurance after a Careful Inspection of the Boilers,

COVERING ALL LOSS OR DAMAGE TO

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The Locomotive.

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The Formation of Scale in Boilers, and in Feed, Circulating, and Blow-off Pipes.

If we could run boilers with perfectly pure water — for example, with water that had previously been distilled — many of the difficulties encountered in actual practice would never arise, and the fireman's duties and responsibilities would be correspondingly lessened and simplified. Unfortunately, this ideal condition of things cannot be realized. We cannot afford to use distilled water, and in most cases feed-water has to be taken in accordance with that mode of selection which is known to the world at large as "Hobson's choice"; that is, we have to take what we can get. In cities and towns good water may usually be had from the city mains; but in sparsely populated districts the manufacturer has to depend upon wells or upon running streams, which

FIG. 1. — A FEED-PIPE NEARLY SEALED UP BY SCALE.

usually serve as sewers for the families of the employés who live along their banks. If there is organic matter in the water trouble is likely to result from corrosion and wasting of the boiler plates; and wells, which are notorious for the "hardness" of the water they furnish, are apt to provide the manufacturer with more scale-forming matter than he can comfortably handle. The water supply of cities is selected with special reference to its fitness for drinking purposes, and for this reason city water is usually comparatively free from organic matter. In most cases it consists of surface water which has not penetrated deeply into the soil, and which has, therefore, had but little opportunity of dissolving mineral matter; but in regions where lime and magnesia abound the city water is likely to be more or less charged with compounds of these substances, and under these circumstances it may be as "hard" as the general run of well waters, and may deposit a copious scale.

The reason why hard water is not good for use in boilers may be stated in a very few words. It is, that whatever may be *put into* a boiler, nothing *leaves* it by the process of evaporation but pure water, in the form of steam. Whatever solid matter may be present, either in solution or as a visible sediment, remains behind in the boiler and continues to accumulate until it is removed by the blow-off or by opening the boiler and washing it out. A steam boiler evaporates an enormous quantity of water in the course of a year, and the total amount of solid matter deposited may, therefore, be very great, even if the water contained only a few grains of it to the gallon. This fact can be well illustrated by a simple example. Thus, let us suppose a 100-horse-power boiler to be running 10 hours a day, and 300 days a year. Furthermore, let us assume that 15 pounds of water per hour are evaporated for each horse-power, and that each gallon of the feed-water contains 30 grains of solid matter in solution. Then the quantity of water evaporated in the course of a year will be

$$100 \times 15 \times 10 \times 300 = 4{,}500{,}000 \text{ pounds.}$$

As a gallon of water weighs about $8\frac{1}{3}$ pounds, this is equivalent to $4{,}500{,}000 \div 8\frac{1}{3} = 540{,}000$ gallons per year. As the solid matter present does not pass off with the steam, it must accumulate in the boiler unless it is periodically removed by blowing or otherwise. We shall assume, for the moment, that the blow-off is not opened, nor the boiler cleaned in any way, until the end of the year. Then as there are 30 grains of solid matter in each gallon of the water, the total weight of the deposit will be $540{,}000 \times 30 = 16{,}200{,}000$ grains; and as there are 7,000 grains in a pound, this is equal to $16{,}200{,}000 \div 7{,}000 = 2{,}314$ pounds, or *more than a ton of solid matter*, in the course of a year. Of course the conditions assumed in this illustration could not exist in practice, because if the boiler were not cleaned in some way, the solid matter, lodging on the plates, would protect them from the water and cause them to burn, and the boiler would be destroyed long before the end of the year. Nevertheless, we have seen many boilers containing hundreds of pounds of deposit which had accumulated in this manner, through neglect, and numerous illustrative examples from such boilers are on exhibition in the Hartford office of this company.

The great bulk of the solid matter deposited from the feed-water may be removed by frequent and judicious blowing. It cannot all be removed in this manner, however, for where the plates are hot, more or less of it is sure to bake on, forming the hard, stony layer known as "scale." The commonest components of scale are carbonate of lime ("limestone") and sulphate of lime ("gypsum"). Carbonate of lime seldom forms a stony scale. It may collect in large masses and do serious injury to the boiler, but the deposits which it forms are usually lighter and more porous than the corresponding deposits of the sulphate of lime. Most substances are more soluble in hot water than in cold; but carbonate of lime is a notable exception to this rule, for although it is somewhat soluble in cold water, in boiling water it is almost absolutely insoluble. It follows from this fact that when feed-water is pumped into a boiler, the carbonate of lime it contains is precipitated in the form of small particles as soon as the temperature of the water reaches the neighborhood of 212°. These particles are whirled about for a considerable time in the general circulation, and if the circulation is good they do not usually settle until the draft of steam is stopped for some reason — as, for instance, in shutting down at night or in banking the fires for the noon hour. The best time to remove this sediment by blowing is, therefore, just before starting up at 1 o'clock, or after the boiler has stood idle for an hour or so at night, or just before beginning work in the morning; for at these times the carbonate deposit has settled into a kind of mud at the bottom of the boiler.

Sulphate of lime differs from the carbonate in being *more* soluble in hot water than in cold; and it is, therefore, not deposited in the same way. The sulphate deposit is formed at those points where the evaporation (and consequent concentration of the solution) is most rapid — that is, in contact with the shell, the tubes, and the back head. Being deposited practically in contact with the iron, it forms a hard, adherent coating, which often resembles natural stone so closely that nobody but a skilled mineralogist could tell the difference between them. The best way to treat water containing sulphate of lime is to convert the sulphate into carbonate, and remove the carbonate thus formed by means of the blow-off, as already described. This can be done, without injury to the boiler, by the use of soda ash, which is a crude carbonate of soda.

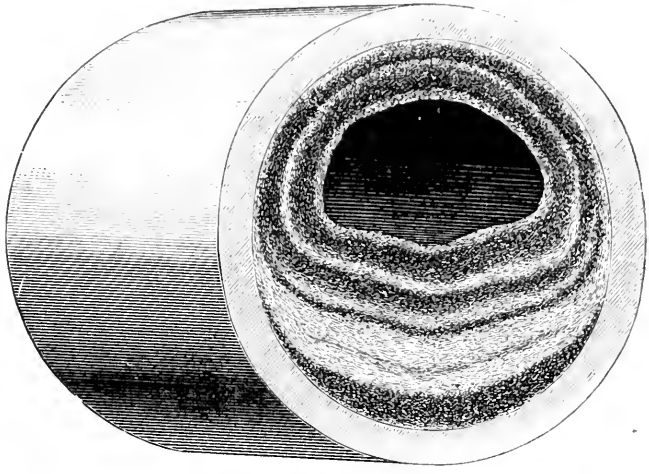

FIG. 2. — A FEED-PIPE CONTAINING A HEAVY DEPOSIT.

The chemical action that takes place may be briefly described thus: *Carbonate of soda* and *sulphate of lime* act upon each other so as to produce *sulphate of soda* and *carbonate of lime*. The sulphate of soda thus produced is what is known in commerce as Glauber's salts. It is very soluble in water, and passes away readily through the blow-off.

A great deal has been published, in the engineering journals, about scale in boilers, and yet very little has been said about the accumulation of it in feed and blow-off pipes. There are mechanical men who maintain that scale cannot accumulate in pipes in which the water is circulating constantly, or nearly so, as in the case of feed-pipes and external or internal circulating pipes; but the cases cited and illustrated in this article will show how fallacious such opinions are. As a matter of fact, these pipes often fill up in a remarkable way, the deposit choking them to such an extent that it becomes a source of positive danger. In Fig. 1, for example, we show the end of a feed-pipe which had become so choked with scale as to be practically sealed up tight. The concretion in this case consists chiefly of carbonate of lime, and, after what has been said of the properties of this substance, the way in which the state of things here shown came about will be readily understood. The feed-water, becoming heated by the steam and water in the boiler, could no longer hold its carbonate of lime in solution, and it was precipitated as described above. Most of the carbonate thus precipitated passed into the general circulation of the boiler in the usual way, but some of it adhered to the end of the feed-pipe, and the deposit thus begun continued to

collect until the state of things shown in the cut was the result. This pipe is an inch and a quarter in diameter, internally, and it was stopped up by the deposit until only a small triangular hole was left, the area of which is about $\frac{1}{125}$ of a square inch.

Fig. 2 shows another feed-pipe in which the deposit was of a similar character, except that it extended back from the end of the pipe to a considerable distance. The history of this pipe is substantially the same as that of the preceding one. In each case the engineer in charge of the plant thought the difficulty was with the pumps, which could not be made to run fast enough to feed the boilers; and in each case investigation showed that the pump was all right, and proved that the trouble lay in the feed-pipe.

The deposit in the pipe shown in Fig. 3 was of a different character. It was solid, stony, and fully as hard as granite. This pipe was originally an inch and a half in diameter internally, but it had become so filled up that the free opening at the end shown in the cut was reduced to a sort of rectangular slit an eighth of an inch wide and less than half an inch long. The sectional area of this slit is estimated to be 0.07 sq. in., and as the original sectional area of the pipe was 1.77 sq. in., it is easily seen that the effective area of discharge was reduced by the deposit to *less than one twenty-*

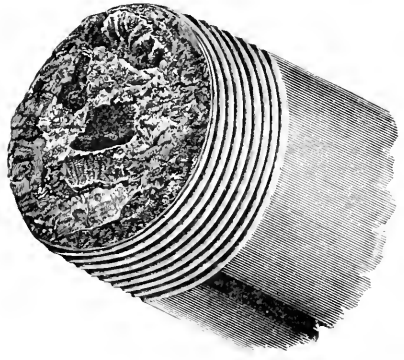

FIG. 3. — A FEED-PIPE CHOKED WITH A STONE-LIKE SCALE.

fifth of the area intended by the builder of the boiler.

The most troublesome form of scale is deposited in pipes that are exposed to the fire; for in such cases the heat causes the sediment to "bake on," so that it can be removed only with a cold-chisel. Blow-off pipes are particularly liable to this trouble because there is no circulation in them, and the sediment that is sure to settle there is directly exposed to the heat of the fire. To avoid the difficulty so far as possible, the blow-cock should be opened at least once a day, and where the water is bad it should be opened three times a day, if only for a few seconds. This will keep it fairly free from deposit, and in a great measure prevent it from burning. (Coverings, or sleeves, are often fitted to blow-off pipes to protect them from the fire. See THE LOCOMOTIVE for September, 1891.) We have often called attention to the importance of using plug-cocks on blow-off pipes — or, at any rate, valves whose opening is straight, and equal to the full diameter of the blow-off pipe itself. If this precaution is neglected there is a liability of fragments of scale lodging in the pipe in front of the valve, and these may cause an accumulation of matter sufficient to stop up the pipe and allow it to burn.

We have spoken, thus far, only of feed-pipes and blow-offs; but what we have

said will of course apply to water-grates, coil heaters, and water-tube boilers generally, with a force varying according to the quality of the feed-water, the design of the apparatus, and the degree of intelligence with which it is used. For example, we have seen the four-inch tubes taken from water-tube boilers, that were almost entirely filled with a hard, sulphate scale. The deposit so formed may protect the tubes and connections from the water to such an extent as to allow of over-heating and burning, giving no end of trouble from the failure of sections and headers and other parts. As an illustration of what may happen in this way we will quote from a report recently received from one of our inspectors, concerning a certain feed-water heating device in the construction of which a number of tubes are used. The device was put in operation on August 22d, and for four months *was thoroughly blown out every six hours.* "On December 17th, the header uniting the 2″ and 4″ pipes in No. 3 boiler stripped the thread, blowing the fire, part of the grate-bars, and a few fire-brick into the room, but fortunately injuring nobody. I had the coil repaired and instructed the fireman to blow out every *four* hours. This coil had some scale in it, but it was not badly choked, *so far as it could be examined.* On December 21st the fireman reported the coil on No. 5 to be *red-hot* at the junction between the 4″ pipe and the back connection. I had the fires drawn and the coil and boiler were examined. The boiler was perfectly clean, but there was considerable scale in the pipe leading from the coil to the boiler. This was cleaned as far as possible, and the boiler was started again. On December 22d in No. 3 boiler ruptured through one of the 2″ coil pipes. We then decided to remove the coil. We had to cut the fittings to get it out, and we found the fittings and the pipes near them to be nearly filled with scale. On December 27th the coil on No. 4 boiler burst in the same way as No. 3. We then began to remove all the coils; but on December 29th No. 5 failed by breaking a fitting, and on December 31st No. 7 ruptured a pipe. At the present time [January 23d], I have had all the coils removed except that on No. 10, and have found in all that the 2″ pipes and fittings are badly choked with scale, some of them being almost completely filled. Until September we used nothing but artesian water; but since then we have used from 10% to 20% of river water." [The river water contains about 24 grains of solid matter per gallon, chiefly lime and magnesia carbonates, with some lime sulphate. The artesian water referred to averages about 10.64 grains of solid matter per gallon, mostly in the form of carbonates.] We quote this case, not because we have any special animosity towards this particular form of heater, but because it is a good illustration of the trouble that may arise from the accumulation of scale in water-tubes exposed to the action of heat.

Inspectors' Report.

JULY, 1894.

During this month our inspectors made 7,698 inspection trips, visited 15,151 boilers, inspected 8,242 both internally and externally, and subjected 630 to hydrostatic pressure. The whole number of defects reported reached 11,160, of which 1,097 were considered dangerous; 61 boilers were regarded unsafe for further use. Our usual summary is given below:

Nature of Defects.	Whole Number.	Dangerous.
Cases of deposit of sediment,	1,015	62
Cases of incrustation and scale,	2,214	80

Nature of Defects.	Whole Number.	Dangerous.
Cases of internal grooving,	126	9
Cases of internal corrosion,	905	20
Cases of external corrosion,	951	87
Broken and loose braces and stays,	169	39
Settings defective,	439	45
Furnaces out of shape,	495	25
Fractured plates,	262	87
Burned plates,	279	33
Blistered plates,	263	37
Cases of defective riveting,	791	44
Defective heads,	199	25
Serious leakage around tube ends,	1,293	226
Serious leakage at seams,	379	20
Defective water-gauges,	339	59
Defective blow-offs,	177	52
Cases of deficiency of water,	27	17
Safety-valves overloaded,	79	21
Safety-valves defective in construction,	100	36
Pressure-gauges defective,	532	39
Boilers without pressure-gauges,	39	39
Unclassified defects,	87	0
Total,	11,160	1,097

Boiler Explosions.

JULY, 1894.

(142.) — On July 2d a steam heater exploded in Milwaukee, Wis., and William Richardson, superintendent of the Milwaukee Mill Furnishing Company, was scalded and otherwise injured. At last accounts his condition was very critical.

(143.) — The boiler of the steamer *Queen* exploded on July 4th in North Thompson River, 12 miles north of Kamloops, B. C. The boat was blown to pieces. Fireman Joseph Rushmond and the cook, Joseph Priet, were instantly killed, and nothing could be found of their bodies. Captain Ritchie was seriously scalded, cut, and bruised, and Engineer Martin was badly hurt.

(144.) — One of the safety boilers in the Silver Spring bleachery, in Providence, R. I., exploded on July 11th. Pasco Chedsey, an Italian, was hauling ashes from the ash-pit of an adjoining boiler at the time. He was thrown some distance and badly scalded by the escaping steam. It is believed that he will recover.

(145.) — A boiler exploded on July 12th in the creamery at Crapaud, near Charlottetown, P. E. I. We did not learn further particulars.

(146.) — On July 14th a boiler exploded at the Eccleson & Parmele Lumber Association's mills, at Jacksonville, N. C. Tony McCann, Sherman Edwards, and Edward Johnson were killed instantly, and Augustus Daniels was scalded so badly that he died two days later. McCann was fireman, and the others were his assistants. The principal part of the boiler, weighing six tons, was found, after the explosion, about 1,000 feet from the mill. In its passage it felled a pine tree two feet in diameter.

(147.) — A small boiler exploded in a wagon-shop in Menommee, Wis., on July 18th, wrecking the building in which it stood. Nobody was hurt.

(148.) — One of the boilers in the Catsburg Coal Company's electric plant at Catsburg, near Monongahela, Pa., exploded on July 18th. The engineer was injured, but not dangerously so. The power-house was somewhat injured, and the property loss was probably about $6,000.

(149.) — The boiler of a threshing engine exploded near Hudson, Ohio, on July 19th. Gabriel Ously was instantly killed. Barney Morgan was fatally scalded, and Edward Carter was injured internally and cannot live. The fire-box was blown into a straw stack, which blazed up and set fire to an adjoining barn so quickly that a dozen men who were in it barely escaped with their lives.

(150.) — Considerable damage was done, on July 19th, by the explosion of a boiler used in connection with the baths in the Jewish synagogue, known as the House of Jacob, in Utica, N. Y. The boiler was situated in the basement, and the explosion tore up a considerable part of the floor in front of the chancel, together with the first three or four rows of seats, fragments of which were blown through the ceiling. Some of the windows were blown out, the chandelier was wrecked, and what had been, a few minutes before, an attractive synagogue, was transformed into a scene of wreck and ruin. Nobody was in the bath at the time, and nobody was injured save the janitor, whose feet were slightly hurt.

(151.) — The boilers in a large saw-mill belonging to White & Co., at Kendall's Station, fifteen miles west of Helena, Ark., exploded on July 19th, killing one man and fatally scalding two others. The mill was totally wrecked. One of the boilers was thrown 500 feet through the tree-tops.

(152.) — A boiler exploded on July 20th in Jachin's hat-shop, in Newark, N. J. Fire followed, and the shop and six frame tenement houses near the boiler-house were destroyed. The account says, "it is believed that several lives were lost."

(153.) — On July 21st a threshing-machine boiler exploded at Deer Creek, near Logansport, Ind. Two men were badly scalded and a third narrowly escaped being killed by pieces of flying débris. The boiler was blown into scraps, and it was considered marvelous that all the men were not killed instantly.

(154.) — On July 22d, while the steamer *Onega* was racing with the *Kindrick*, about forty miles from Chattanooga, one of the flues in her boiler collapsed. Frank Butler, who was directly in front of the boiler, was deluged with steam, boiling water, and burning coals. He cried out, "Men, I'm killed," and sprang into the river. He did not come to the surface again, and it is not known whether he died from the burns or was drowned. His body could not be found.

(155.) — The boiler of a hoisting engine exploded on July 23d at the Savannah, Florida & Western railway wharves at Savannah, Ga. The hoisting engine was blown into the air and the smoke-stack fell sixty feet away. Live coals were blown into the hold of the *Concezione*, an Italian bark with a cargo of sulphur. The sulphur took fire in two places, and was extinguished with difficulty. The engineer says that the steamer gauge registered 55 pounds at the time of the explosion. The safety-valve was set at 80 pounds.

(156.) —A big boiler exploded on July 24th in the water pumping station and electric light plant in Perry, Iowa. The power-house was literally blown to atoms, not

one brick being left in its place, and the wreckage was strewn over several blocks. The water-works belonged to the city and the electric light plant to a private company, but both were in the same building. The dynamos and the city pumps were torn from their foundations and "twisted out of all semblance to their former shape." The explosion took place about 7 o'clock, while the men were at supper, and the only person about the place was Mr. H. C. Hock, manager of the Electric Light Company. Mr. Hock was fearfully injured, and will undoubtedly die. John Blougher, who was driving past the building in a buggy, was struck on the head by a brick and knocked senseless. The property loss was probably about $15,000.

(157.) — On July 24th a boiler exploded in the creamery at Harmon, near Sterling, Ill. Nobody was present at the time. The smoke-stack was blown down and the building was considerably damaged. We have seen no estimate of the property loss.

(158.) — The boiler in McNeil's mill, at Gloster, Miss., exploded on July 24th. John Anderson was killed instantly, and George Shropshire and James Blaylock were fatally scalded.

(159.) — A boiler exploded, on July 25th, at the electric plant of the Will mine, in Monongahela City, Pa. A man named Spence received injuries that will probably prove fatal. The property loss was about $6,000.

(160.) — On July 26th a boiler exploded in Yancy & Dyer's flouring mill, at New Cassel, near Fond du Lac, Wis. The mill was wrecked, and Lowell Dyer, a young man of 18, was fearfully scalded, so that he died a few hours later.

(161.) — By the explosion of a saw-mill boiler at Poplar Grove, Ind., on July 26th, William Williams was killed and two other men were injured.

(162.) — The boiler of freight engine No. 82, on the Wabash road, exploded on July 27th at Ashwood, near Defiance, Ohio. Traffic was delayed several hours. We did not learn further particulars.

(163.) — One of a battery of twenty-one boilers exploded on July 28th at Packer colliery No. 4, operated by the Lehigh Valley Coal Company, at Ashland, Pa. John Miller was killed instantly, and John Laubach, Darby Shields, and John Malingo received injuries from which they died in a short time. Steven Shelsick was also painfully injured, but he will recover. The east end of the boiler-house was blown out, the roof was considerably damaged, and one of the large smoke-stacks was knocked down.

(164.) — A slight boiler explosion occurred on July 30th in the creamery at Lyndon, Kan. The account that we received says, "things let loose, and the flues went out at the top of the boiler." The damage was small, and it does not appear that anyone was hurt.

(165.) — The boiler of a Canadian Pacific consolidation engine exploded near Field, B. C., on July 30th, while pushing a freight train up a steep grade known as "the hill." The locomotive was blown to pieces and Engineer Wheatley and Fireman Hunt were killed instantly. George Kemp, a brakeman on the rear car, was fatally injured by flying fragments of the boiler. (He died on August 1st.)

(166.) — On July 31st a boiler exploded in Atkinson's mill, at Mount Vernon, Ill. John Atkinson, the proprietor, was thrown a distance of fifty feet, and instantly killed.

Flying by Steam.

Figuratively speaking, flying machines have been in the air for some months past. More than this, some have actually flown over distances to be measured in hundreds of feet, and within the limits of their construction have been successful. But they have all been models rather than actual machines. None of those that have hitherto been described in our columns have been designed to carry a crew, or have ever been provided with motive power sufficient to keep them in action over more than short periods. But last Tuesday, July 31st, for the first time in the history of the world, a flying machine actually left the ground, fully equipped with engines, boiler, fuel, water, and a crew of three persons. Its inventor, Mr. Hiram Maxim, had the proud consciousness of feeling that he had accomplished a feat which scores of able mechanics had stated to be impossible. Unfortunately, he had scarcely time to realize his triumph before fate, which so persistently dogs the footsteps of inventors, interposed to dash his hopes. The very precautions that had been adopted to prevent accidents proved fatal to the machine, and in a moment it lay stretched on the ground, like a wounded bird with torn plumage and broken wings. Its very success was the cause of its failure, for not only did it rise, but it tore itself out of the guides placed to limit its flight, and for one short moment it was free. But the wreck of the timber rails became entangled with the sails, and brought it down at once. The machine fell on the soft sward, embedding its wheels deeply in the grass, and testifying, beyond contradiction, that it had fallen and not run to its position. If it had not been in actual flight, the small flanged wheels would have cut deep tracks in the yielding earth. . . . The propelling power is derived from two screws 17 ft. 6 in. in diameter, revolving at 400 revolutions per minute, and giving a total thrust of 2,000 pounds. Each screw is driven by a compound engine, both engines drawing their steam from a tubular boiler of most ingenious construction. The weight of the boiler, complete, with 200 lbs. of water, is only 1,200 lbs., and yet Mr. Maxim contrives to get 300 horse-power out of it. The fuel is gasoline, which is gasified and burned as a gas from several thousand jets, and the whole arrangement is so sensitive that the steam pressure can be raised 100 lbs. in a minute if required. At every point in his design Mr. Maxim has been obliged to leave the beaten track of mechanics and find new paths. Indeed, the machine constitutes a perfect museum of inventions, and would repay hours of study. . . . The boiler, with its accessories, is mounted on the deck of the machine. The engines are carried by the framing, several feet higher, in order that the screws may be well elevated. Over all comes the great aëroplane of 1,400 square feet area, designed to glide over the surface of the air, and to carry the major part of the weight. From each side of this great aëroplane, which is 50 feet wide, stretches a wing extending 38 feet further, making the entire stretch from side to side 126 feet. Two other wings, of about equal size, extend outward a few feet from the ground, and, if need be, three other pairs can be interposed between the upper and lower wings. These are all carried by a framing of steel tubes and wires, and are stiffened by hollow timber struts which are marvels of workmanship. These wings and aëroplanes are all fixed, and have no motion relative to the machine. The steering, in a vertical direction, is done by a pair of horizontal planes, arranged one forward and one aft. These are pivoted and connected by wire ropes to a steering wheel on deck, by which they can be simultaneously tilted to cause the machine to soar or to descend. Steering sidewise can be effected, as in a ship, by varying the speed of the screws.— *Engineering* (London).

The Locomotive.

HARTFORD, SEPTEMBER 15, 1894.

J. M. ALLEN, *Editor.* A. D. RISTEEN, *Associate Editor.*

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WE desire to acknowledge the *Report* for 1893 of the Hannover Verein zur Ueberwachung der Dampfkesseln, and also that of the Milan Associazione fra gli Utenti di Caldaie a Vapore.

MR. HENRY ADAMS of Baltimore, Md., kindly sends us the following correction: "I notice in your July issue an error in the brief article on *Congressional Ventilation.* You mention that sixteen fans are used for the House of Representatives. There are only six employed, and of these four are practically of no use." We thank Mr. Adams for the correction, which we make with pleasure. As stated in the article in question, our information was obtained from the daily press.

Professor Helmholtz.

Professor Hermann Ludwig Ferdinand von Helmholtz, the celebrated German physicist and physiologist, died in Berlin, on September 8th, of paralysis. Professor Helmholtz was born in Potsdam, Prussia, on August 31, 1821, and was graduated as a physician from the royal military school in Berlin at the age of 21. His first great contribution to science was his classical memoir on *The Conservation of Energy*, which appeared in 1847, and which alone would have been sufficient to ensure him a lasting fame. In 1858 he published his remarkable mathematical researches on the motion of vortices ("smoke rings"), which were of especial interest on account of their bearing on a certain theory of the ultimate structure of matter, called the "vortex theory," and due, we believe, to Lord Kelvin. In 1862 he gave to the world his marvelous book on *Sensations of Tone, as a Physiological Basis for the Theory of Music*, which was followed, five years later, by the *Manual of Physiological Optics.* Throughout his long life he was ardently devoted to science, and paid little or no attention to politics or other matters outside his own line of work. He had a fine face and a fine figure, and was very popular among his students and among the German people generally. He received the Copley medal of the Royal Society of London in 1873, and in 1883 he was "ennobled" (if an official act of a king could ennoble such a man) by Emperor William I, in recognition of his important contributions to science. He attended the World's Fair in 1893, and while in New York he spoke before the College of Physicians and Surgeons on the ophthalmoscope, of which instrument he was the inventor.

Thin Films of Gold.

In the July issue of THE LOCOMOTIVE (page 116) we referred to the extremely thin films of gold recently produced by Mr. J. W. Swan. We learn, from the September issue of the *Journal of the Franklin Institute*, that Mr. J. B. Outerbridge made use of the same process, in this country, as long ago as 1877. "One of the interesting exhibits made at the recent *conversazione* of the Royal Society, held June 13, 1894," says the *Journal*, "was that of Mr. J. W. Swan, F.R.S., who presented a number of specimens of leaves of gold of extreme thinness, which had been prepared by the process of electro-deposition. From a brief notice of the exhibit, published in London *Nature*, it appears that it represented an attempt by Mr. Swan, to produce gold leaf by electro-chemical, instead of mechanical means. 'The leaves were prepared by depositing a thin film of gold on a highly polished and extremely thin electro-copper deposit. The copper was then dissolved by perchloride of iron, leaving the gold in a very attenuated condition. The leaves were approximately four one-millionths of an inch thick, and some of them mounted on glass showed the transparency of gold very perfectly when a lighted lamp was looked at through them.' It will doubtless prove somewhat of a surprise to Mr. Swan to learn that identically the same method of procedure for the production of films of metal of extreme tenuity was described and illustrated by Mr. A. E. Outerbridge, Jr., in a lecture delivered before the Franklin Institute in 1877, an abstract of which was published in the *Journal*.* At the stated meeting of the Institute held May 16, 1877, the then resident secretary, the late Mr. J. B. Knight, made reference in his monthly report to the thin gold films produced by Mr. Outerbridge in the following terms:†

"'In the course of a lecture on gold, delivered before the Franklin Institute, on February 27th last, Mr. A. E. Outerbridge, Jr., of the Assay Department of the Mint in this city [Philadelphia], gave an account of some experiments he had made, with the view of ascertaining how thin a film of gold was necessary to produce a fine gold color. The plan adopted was as follows: From a sheet of copper rolled down to a thickness of $\frac{5}{1000}$ of an inch, he cut a strip $2\frac{1}{2}\times4$ inches. This strip, containing 20 square inches of surface, after being carefully cleaned and burnished, was weighed on a delicate assay balance. Sufficient gold to produce a fine gold color was then deposited on it by means of the battery; the strip was then dried without rubbing, and re-weighed, and found to have gained $\frac{1}{10}$ of a grain, thus showing that one grain of gold can, by this method, be made to cover 200 square inches, as compared with 75 square inches by beating. By calculation, based on the weight of a cubic inch of pure gold, the thickness of the deposited film was ascertained to be $\frac{1}{980400}$ of an inch, as against $\frac{1}{367650}$ for the beaten film. An examination under the microscope showed the film to be continuous and not deposited in spots, the whole surface presenting the appearance of pure gold. Not being satisfied, however, with this proof, and desiring to examine the film by transmitted light, Mr. Outerbridge has since tried several methods for separating the film from the copper, and the following one has proved entirely successful. The gold plating was removed from one side of the copper strip, and by immersing small pieces in weak nitric acid for several days, the copper was entirely dissolved, leaving the films of gold, intact, floating on the surface of the liquid. These were collected on strips of glass, to which they adhered on drying, and the image of one of them is here projected on the screen, by means of the gas microscope. You will observe that it is entirely continuous, of the characteristic bright green color,

* *J. F. I.*, ciii. 284. † *J. F. I.*, ciii. 369.

and very transparent, as is shown by placing this slide of diatoms behind the film. By changing the position of the instrument, and throwing the image of the film on the screen by means of a reflected light, as is here done, you will see its true gold color. Mr. Outerbridge has continued his experiments, and, by the same processes, has succeeded in producing continuous films, which he determined to be only the $\frac{1}{2798000}$ of an inch in thickness, or one 10,584th the thickness of an ordinary sheet of printing-paper, or only one 60th the length of a single undulation of green light. The weight of gold covering 20 square inches is, in this case, $\frac{35}{1000}$ of a grain, one grain being sufficient to cover nearly 4 square feet of copper. As you see, the film is perfectly transparent and continuous, even in thickness, and presents all the characteristics of the one shown before. That a portion of the image appears darker is due to superposed films, the intensity of the green color being proportional to the thickness through which the light passes.'

"It may be stated, in conclusion, that the mode of procedure above described was patented by its author* under the title 'Manufacture of Metallic Leaf.' In his patent the inventor describes, as 'a new and improved method of manufacturing gold leaf, silver leaf, and other metallic leaf,' the above-named method of electrical deposition. As suitable mediums to support his films, he mentions copper in thin sheets, and paper, shellac, wax, etc., made conductive upon the surface which is to receive the deposit. For removing the deposited film from copper and paper, Mr. Outerbridge describes the use of a bath of dilute nitric acid, or of perchloride of iron. In the case of the shellac, wax, etc., alcohol, benzine, and other solvents are referred to.

"While these circumstances detract neither from the interest nor the genuineness of Mr. Swan's work, they are recalled in this place in justice to Mr. Outerbridge, to whom priority is undoubtedly due."

Measuring Cards with the Planimeter.

We have received numerous inquiries, recently, about the use of the planimeter in measuring indicator cards. The usual question that we are asked is, Why must one divide the area of the card by its length? The present article is intended as an answer to this question.

In the first place it is important to remember *what an indicator card is.* It is nothing more nor less than a record of the pressures that existed in the cylinder at every part of the revolution during which the card was taken. The length of the card represents the stroke of the engine, and the height of any point in the card, measured from the atmospheric line, represents the pressure that existed in the cylinder when the indicator pencil was passing that point. The *scale* on which the pressures are recorded depends upon the stiffness of the spring that was used. The springs that are supplied with indicators are always stamped with numbers that show what the corresponding scale of the card is. For example, if the number "40" is stamped on a particular spring, the maker of the instrument intended the pencil to rise one inch for every 40 pounds pressure when this spring is used. To illustrate this point further, let us refer to Fig. 1, which represents an indicator card taken with a "50" spring. If we wished to know the pressure in the cylinder when the piston has traveled three-quarters of the forward stroke, we proceed as follows: Three-quarters of the way from *A* to *B* we draw the vertical line *ab.* Upon measuring the length of *ab* we find it to be (say) $\frac{5}{16}$ of an inch. Then the pressure in

* U. S. Patent, 198,209, December 18, 1877.

the cylinder when the piston had traveled three-quarters of the stroke was $\frac{5}{16} \times 50 = 15\frac{5}{8}$ pounds per square inch. To find the pressure in this end of the cylinder (*i. e.* the "back pressure") when the piston has traveled say $\frac{5}{6}$ of the return stroke, we proceed in a similar manner, drawing the line *cd*, $\frac{5}{6}$ of the way from *B* to *A*, and measuring it.

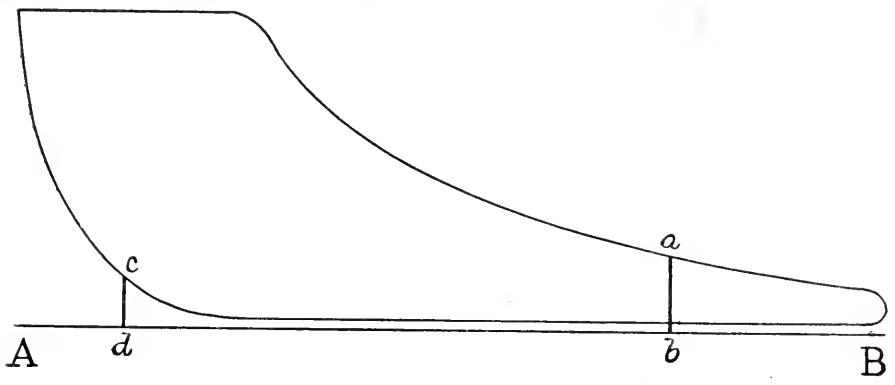

Fig. 1. — To Find the Pressure at any Point in the Stroke.

Suppose we found the length of *cd* to be $\frac{5}{32}$ of an inch. Then the back-pressure at this point in the stroke was $\frac{5}{32} \times 50 = 7\frac{13}{16}$ pounds per square inch.

What we want, in calculating the horse-power of the engine, is the *average pressure* in the cylinder. We can get this closely enough for most purposes by the method shown in Fig. 2. In applying this method the card is first divided up into ten equal spaces, as shown by the heavy vertical lines. These lines may be spaced by a pair of

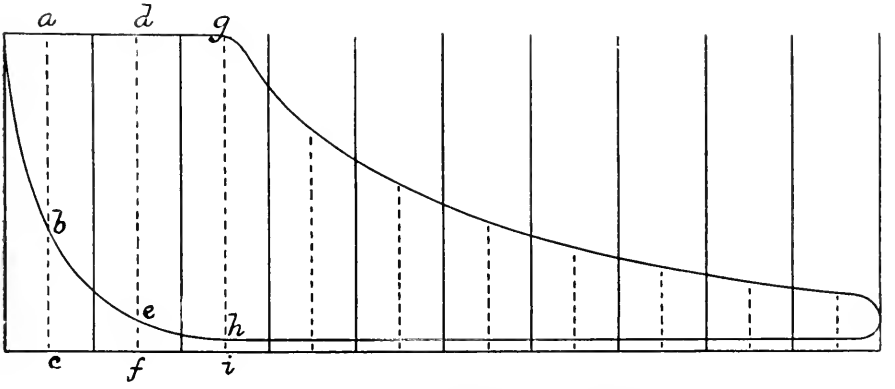

Fig. 2. — Finding the Average Pressure.

good dividers, but the easiest way to draw them is by means of the "gridiron" shown in Fig. 3, which can be had of all dealers in indicators.

The method of using the gridiron will be readily understood from the cut. When the card has been divided up by either of these methods, into ten equal spaces, we proceed to measure the height of each one of these spaces, as shown by the dotted lines *ac*, *df*, *gi*, etc.; *ac* representing the average pressure during the first tenth of the stroke, *df* the average pressrue during the second tenth, and so on. The average of all these lines

will then give the *average pressure during the forward stroke.* The back-pressure, or pressure during the return-stroke, is found in the same way, by averaging the lines *bc*, *ef*, *hi*, etc. The average "effective pressure" (that is, the pressure useful in driving the engine) is then found by subtracting the average back-pressure from the average pressure during the forward stroke.

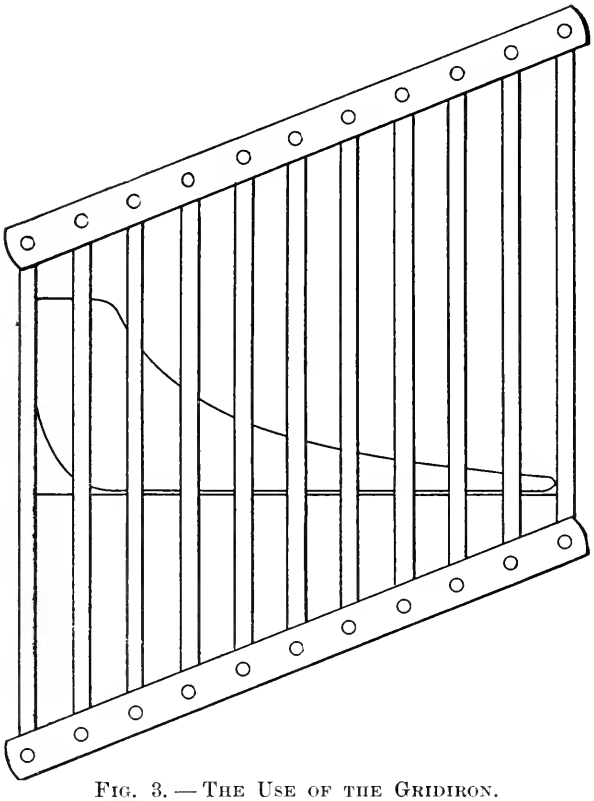

FIG. 3. — THE USE OF THE GRIDIRON.

It is easily seen that this long operation can be very much simplified by merely taking the average of the lines *ab*, *de*, *gh*, etc.; for this must give the same result as measuring the whole line and afterwards taking away the lower part. Now the average of the lines *ab*, *de*, *gh*, etc.; is nothing more or less than the average width of the card, as will be apparent upon referring to Fig. 4, which is the same as Fig. 2, except that the lower lines have been left out for greater clearness. We have therefore arrived at the following important fact: The average effective pressure in one end of the cylinder of an engine is represented by the *average width* of the card taken from that end; and this average effective pressure can be found, expressed in pounds per square inch, by

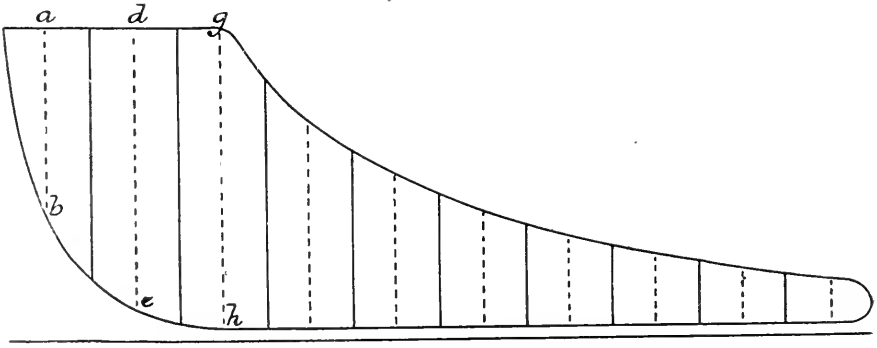

FIG. 4. — FINDING THE AVERAGE PRESSURE.

multiplying the average width of the card, in inches, by the number of the spring that was used in taking the card.

The only reason why we use a planimeter, in figuring up engine cards, is that that instrument gives us an accurate and extremely simple method of *finding the average width* of the card. It enables us to do away with the gridiron and the dividers and the vertical lines, altogether. To understand how this is, let us reflect that we could find the *area* of the card, if we wished to do so, by merely multiplying the *length* of the card by its average *width*. On the other hand, if we knew what the area was, we could find the average width by dividing the given area by the length. Now the planimeter enables us to find the *area* of the card without the least calculation; and for this reason it is much easier to find the *average width* by *dividing this area by the length of the card*, than it is to determine the average width by direct measurement of the lines in Fig. 4.

This is the whole story, except that we have not told *why* the planimeter gives the area of the card; but, as Mr. Rudyard Kipling would say, that part of it really "belongs to *another* story" — a much more difficult one to tell, too. Many proofs of the working of the wonderful little instrument have been given, and yet we fancy that no thoughtful man ever works with it without feeling that there is something almost "spook-like" about it.

The Speed of Vessels.

Lloyd's latest publication shows that out of the 13,000 steamers recorded in the "Registry," only 45 vessels have a speed of 19 knots and above, and of this number 18 are credited with a speed of 20 knots or over. Of the former number, 25, or more than half, were built on the Clyde, while of the 20-knot boats 12 are Clyde built, 3 have been constructed in other parts of the kingdom, leaving 3 for abroad. Foreign builders constructed a dozen of the 45 of 19 knots and over, but, on the other hand, foreigners own 20 of these 45. The remarkable fact is that of the 20-knot boats 9 are paddle steamers and 9 twin-screw, none being single-screw. For high speeds, therefore, the single-screw is of the past; and it might also be said that the side-paddles are giving place to twin-screw propulsion. The difficulty hitherto has been the draught of water available, the paddle requiring less water in which to work than the screw propeller, which must be completely immersed. But when it is remembered that in action the screw propeller is similar to a wheel revolving, it will be understood that by increasing the revolutions it is possible to reduce the diameter and still get the same speed. Improved types of engines make this higher number of revolutions possible, but at the same time more careful work in construction is required. A few years ago 90 revolutions was high; now 200 is exceeded in several vessels, and 400 has been reached in torpedo craft. Another circumstance which makes the screw preferable is that it has, as a rule, only half the slip of the side-paddles. Slip is used in the same sense as in the case of a locomotive wheel. The slip of a 20-knot paddle-steamer is 26 to 30 per cent. the forward motion, against 13 to 15 per cent. in a twin-screw steamer. Again, the proportion of weight of machinery to the total weight of the steamer is less in a screw steamer, since more has been done to lighten the parts than with the paddle-engine. In the latter 8½ I.H.P. has been got per ton weight, in the former 11 I.H.P. per ton. In a paddle-steamer 45 per cent. of the total weight goes in engines; in a screw-steamer, where more provision is made for cargo, only 31 per cent. of the total is for machinery. — *Glasgow Herald.*

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Concerning Blow-off Pipes.

In the September issue of THE LOCOMOTIVE, in speaking of the deposit of sediment and the formation of scale in pipes, we referred to the use of straight-way valves on blow-offs, and stated that the opening in such valves should be fully equal to the sectional area of the blow-off pipe itself. As the importance of this point is not always

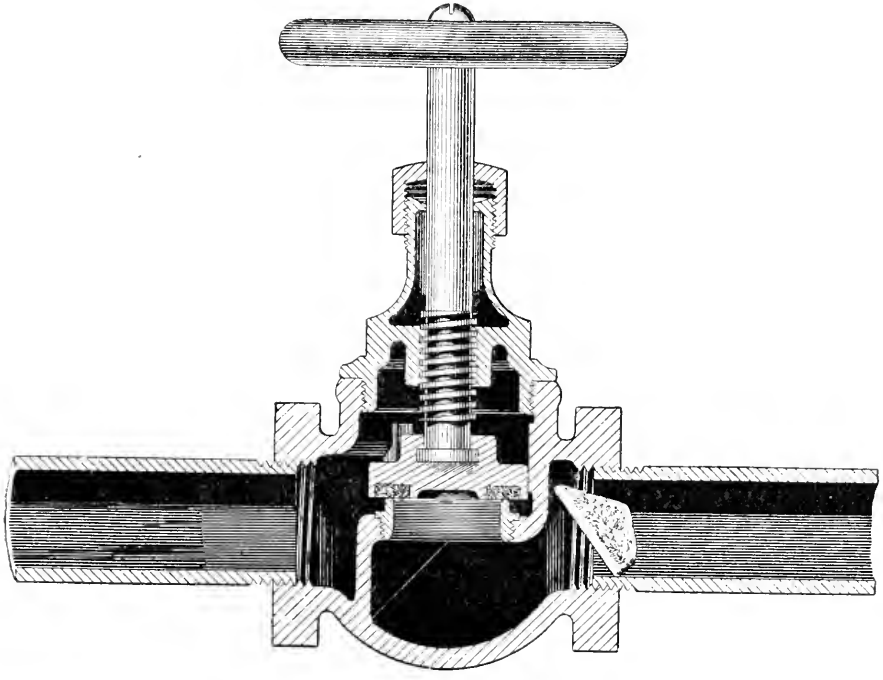

FIG. 1. — A GLOBE VALVE APPLIED TO A BLOW-OFF PIPE.

thoroughly appreciated, we herewith present two cuts (Figs. 1 and 2) which will suffice, it is hoped, to make the matter clear. Fig. 1 represents a globe valve as applied to a blow-off pipe, and we have endeavored to illustrate the fact that such a valve is liable to trap pieces of scale that have flaked off from the shell (or tubes) of the boiler. The same action may take place with any other form of valve in which the passage is not straight, or which has an opening of less area than the blow-off pipe itself. Fig. 2 illustrates a straight-way valve having an opening a trifle greater than the area of the

pipe, and it will be evident, at once, that in such a valve there is far less chance for scale to lodge. It is important, however, even with straight-way, full-area valves, to open the valve wide when the boiler is blown, so that the full area may be *realized*. If, for example, the form shown in Fig. 2 be opened only a little, there is an excellent chance for fragments of scale to lodge against the plug, and such fragments may become so compacted together that when the valve *is* thrown wide open at some subse-

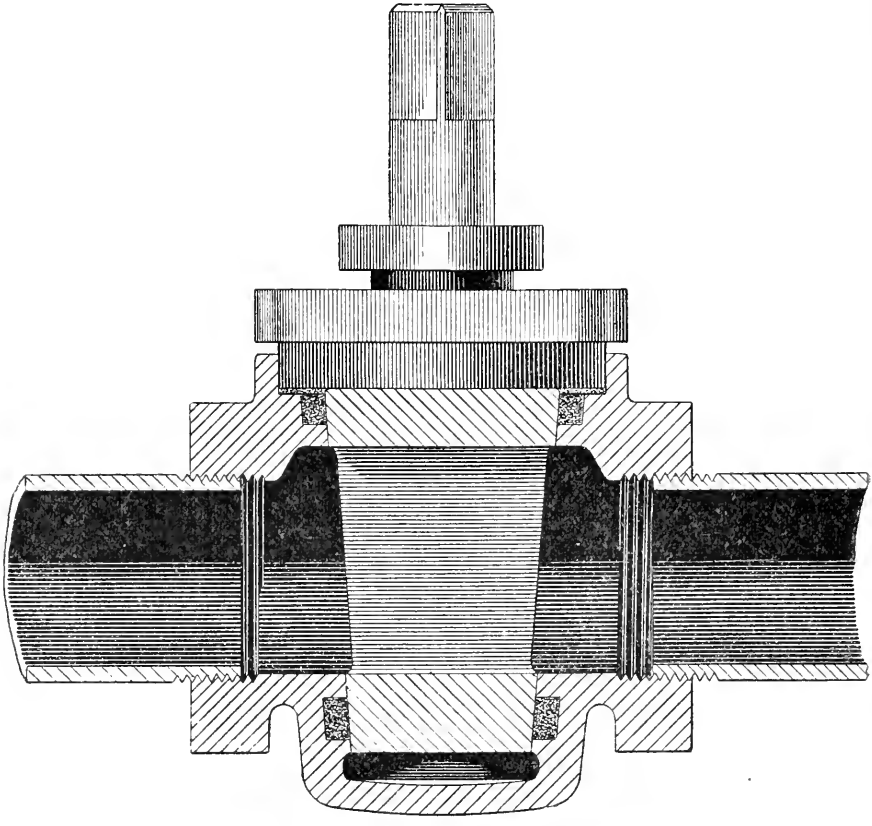

FIG. 2 — A PLUG COCK ON A BLOW-OFF PIPE.

quent time, the full boiler pressure may not suffice to blow the impediment out, and the result is likely to be the more or less complete filling up of the pipe, and its subsequent overheating and rupture. Even when the valve is to be opened only for a few seconds, it should be opened *wide*. It is by no means uncommon to reduce the size of the blow-off somewhat, after it leaves the boiler. This should never be done, for where the reduction occurs there is the same chance for the accumulation of scale that there is in a valve having a diminished area, and the same unpleasant and perhaps disastrous consequences may follow.

Although we consider the straight-way, full opening valve to be superior, for use on blow-off pipes, to globe valves or other forms that have tortuous or contracted pass-

ages, they must be used with judgment or they are liable to cause trouble of another kind, which we proceed to explain. To take a concrete example, let us consider a boiler carrying 80 pounds of steam, and let us suppose that the blow-off valve is opened wide. Then it is easy to show, by the principles of hydrodynamics, that, if friction be disregarded, the water that escapes through the blow-off will have a velocity of about 109 feet per second. Now, while the column of water in the pipe is moving with this velocity, let us suppose that the plug cock is *suddenly closed*. The very considerable momentum of the mass of moving water in the pipe is bound to make itself felt, and

FIG. 3. — ILLUSTRATING THE "WATER RAM" IN BLOW-OFF PIPES.

the energy of this mass of water, due to its velocity of 109 feet per second, is expended upon the pipe and its fittings, in producing strains in the material of which they are composed. That this action is well worth serious attention is easily made apparent by considering the appliance known as the hydraulic ram. The hydraulic ram is a device for raising water by means of the very momentum we are considering. Water is allowed to flow through a "waste-pipe" until it acquires a considerable velocity, and the waste-pipe is then suddenly closed by an automatic clack-valve. The pressure in

FIG. 4. — ILLUSTRATING THE "WATER RAM" IN BLOW-OFF PIPES.

the waste-pipe at once increases greatly, owing to the momentum the water has acquired, so that a part of the water escapes through a check-valve, into a delivery pipe connected with a reservoir considerably higher than the level of the pond from which the main supply is taken. By properly designing such a ram, it is found to be possible, in actual practice, to make the resulting momentum-pressure exceed the static pressure due to the normal head of water in the waste-pipe, by *twenty fold* — the practicable delivery-head of the ram being 20 times the supply-head. If this same increase in pressure could be realized in the case we are considering, the pressure in the blow-off pipe would rise to $20 \times 80 = 1{,}600$ pounds per square inch, when the valve is *suddenly closed*. We do not affirm that such an extraordinary excess of pressure as this

does occur in blow-off pipes, and yet we believe that this computation will satisfy the reader that it is not a good plan to trifle with plug-cocks in any such way as we have described, and that the danger we have suggested is not imaginary, but real, and worthy of serious consideration. What the actual increase in pressure in blow-off pipes, from this cause, may be, we cannot say; but we do know that accidents frequently occur, in connection with such pipes, which appear to be unmistakably due to the ram-like action that we have just described. All trouble of this kind can be avoided by always closing the valve *slowly*.

The effects of the sudden rise in pressure that occurs in a blow-off pipe when the valve is closed too quickly are naturally felt most in the fittings, which are almost invariably made of cast-iron. This is indicated by the arrows in Figs. 3 and 4, which illustrate two common ways of putting in blow-off pipes. The elbow is liable to break, or the valve itself may fail, or the pipe may burst, or the threads on the pipe or the fittings may strip (though this last-mentioned mode of failure is not so common as the others). We have also seen pieces knocked out of an elbow, or a valve, from this cause, while the greater part of the fitting still remained intact. The pipe or the fittings may withstand the rough usage that they often get, for a considerable time, and yet each shock leaves its impress on the material, and some day the blow-off fails somewhere, and somebody is burned and scalded. At such a time the front of the boiler may be an even more dangerous place than the rear, for the fire-doors are usually blown open, and the fire is blown out into the room, together with great volumes of steam and boiling water. Fig. 5 represents a fragment of a blow-off fitting that was broken in an accident of this kind that recently came to our notice.

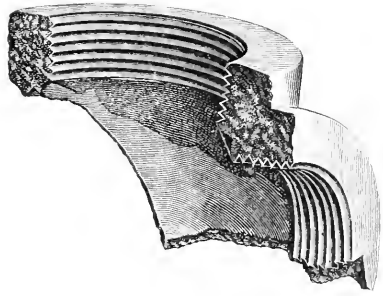

FIG. 5. — A BROKEN FITTING.

Feed-pipes are often made of brass, as this material is not apt to be destroyed by pitting (unless there is some corrosive substance present in the water), and, moreover, brass pipes give the boiler-room a neat and attractive appearance. For these reasons, boiler owners are not unfrequently led to use brass for blow-off pipes also, not realizing that the conditions to which blow-off pipes are commonly exposed are radically different from those pertaining to feed-pipes. There is no objection to the use of brass in connection with locomotive, vertical-tubular, and other types of *internally* fired boilers, for in these cases the blow-off is not exposed to the fire, and brass proves to be efficient and durable. The nature of brass, however, is such that the metal will become soft, and lose its strength, at temperatures that do not injure iron. It seems to be the fact, too, that *all* alloys deteriorate when exposed to moderately high temperatures for a sufficient length of time. Safety-plugs, when filled with alloys, often become so modified by long exposure to heat that their contents will not melt out until the temperature greatly exceeds what was originally intended to be the melting point of the alloy; and it is on this account, largely, that we recommend pure tin for the filling. When a blow-off pipe is directly exposed to the heat from the fire (as it is in horizontal tubular boilers) steam must be generated in it, to some extent, and the film of steam next to the metal, by preventing the contact of water, may allow the pipe to be heated to such a temperature that the brass will become burned, or will at least soften. Such sediment as may adhere to the inside of the pipe also contributes to the same end. As the result of these vari-

ous causes — that is, deterioration of the alloy when exposed to heat, the softening, and the loss of tensile strength due to the high temperature, etc., — it often happens that brass blow-offs burst, doing considerable damage, and subjecting the owner of the plant to annoying delays until the boiler can be put in use again. Fig. 6, which represents a brass blow-off that burst recently in this neighborhood, shows what may be expected, in the course of time, from such a pipe when exposed to the heat of the fire. This pipe burst one Monday morning, while the steam pressure was 80 pounds per square inch. The rear door of the setting happened to be braced in position by a bar of iron, but the furnace doors were blown open, and the engineer was badly burned and scalded. The pipe was $\frac{3}{16}$ inch thick. Sleeves of cast-iron or other material are often provided for the protection of blow-off pipes,* and while these are certainly advantageous, they can

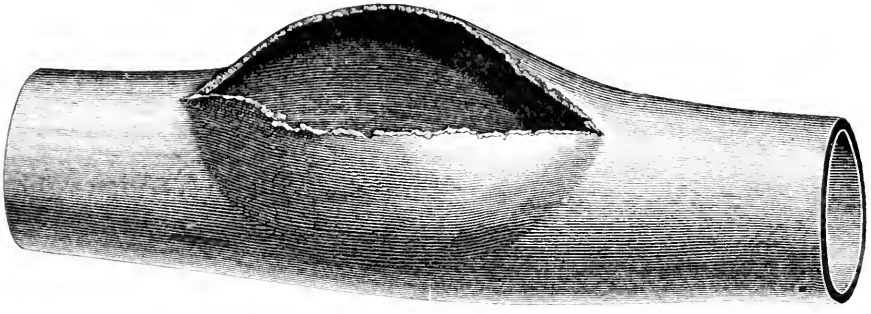

FIG. 6. — A RUPTURED BRASS BLOW-OFF PIPE.

never make a brass blow-off, on an externally fired horizontal tubular boiler, as satisfactory as one constructed of good, extra heavy, iron steam pipe.

Brass and copper blow-off pipes are open to another objection, which is illustrated in Fig. 7. The pipe here represented is of brass, and it was originally $\frac{5}{32}$ of an inch thick. The part BC was protected by the rear wall of the setting, while AB was exposed to the heat of the fire. The pipe wasted away, externally, along the part AB, until its thickness was reduced, in places, to less than $\frac{1}{32}$ of an inch. (This is shown on an exaggerated scale in the cut. In the actual pipe, now in this office, from A to B

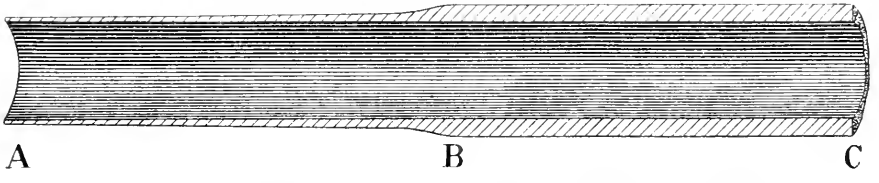

FIG. 7. — A BRASS BLOW-OFF PIPE, WASTED AWAY EXTERNALLY.

is 26 inches, and from B to C 21 inches. The pipe is 2 inches in diameter, internally.) The reduction in thickness was uniform all around the pipe, and the effect was very much the same as would be observed if the pipe had been placed in a lathe and gradually worn away by the application of emery cloth. For some reason or other it did not burst, but held together until the boiler was temporarily put out of use, when its condition was discovered. This phenomenon, which is not perfectly understood, is by no

* See THE LOCOMOTIVE for September, 1891.

means uncommon where brass and copper are used for blow-offs. In a nest of three boilers, recently inspected by this company, all the blow-offs (which were copper) were found to be in a condition precisely similar to that shown in Fig. 7. It is believed that the loss of material from the outside of such pipes is due, to some extent at least, to the grinding action of small particles of unconsumed solid matter that are carried along by the draft, the action being analogous to that of a sand-blast. The objections to this theory are, first, that in such a case one would naturally expect the wear to be most rapid along the bottom of the pipe, where the particles strike it most directly; the fact being, however, that the pipe wastes away about equally, all around its circumference. The second objection to the sand-blast theory is, that although, judging from the general properties of the materials, one would expect iron pipes to wear away from attrition even faster than brass ones, the fact is, that iron blow-off pipes exhibit the phenomenon to a barely perceptible extent, if at all. We are therefore impelled to the conclusion that the wasting away of the brass and copper pipes is to be attributed, to some extent, to chemical action. It is not unlikely that some of the products distilled off from the fire may act corrosively on copper and brass, while leaving iron comparatively unaffected. However this may be, the important thing to note is, that *the phenomenon occurs;* and hence, whatever its cause may be, it is a source of danger to be borne in mind and to be provided against. And the easiest way to provide against it is to put in an *iron* blow-off pipe.

Inspectors' Report.

AUGUST, 1894.

During this month our inspectors made 7,325 inspection trips, visited 14,730 boilers, inspected 6,309 both internally and externally, and subjected 656 to hydrostatic pressure. The whole number of defects reported reached 10,757, of which 1,261 were considered dangerous; 31 boilers were regarded unsafe for further use. Our usual summary is given below:

Nature of Defects.	Whole Number.	Dangerous.
Cases of deposit of sediment,	739	35
Cases of incrustation and scale,	1,824	93
Cases of internal grooving,	114	10
Cases of internal corrosion,	745	30
Cases of external corrosion,	661	24
Broken and loose braces and stays,	117	29
Settings defective,	430	39
Furnaces out of shape,	397	15
Fractured plates,	224	35
Burned plates,	213	13
Blistered plates,	265	17
Cases of defective riveting,	1,427	134
Defective heads,	86	17
Serious leakage around tube ends,	1,753	485
Serious leakage at seams,	448	33
Defective water-gauges,	399	67
Defective blow-offs,	175	53
Cases of deficiency of water,	19	6
Safety-valves overloaded,	70	40
Safety-valves defective in construction,	108	40
Pressure-gauges defective,	475	41
Boilers without pressure-gauges,	5	5
Unclassified defects,	63	0
Total,	10,757	1,261

Boiler Explosions.

August, 1894.

(167.) — By the explosion of a boiler in the St. Joseph Valley Paper Company's mill at Elkhart, Ind., on August 1st, James Hiatt, the fireman, was seriously injured, and the building was considerably damaged.

(168.) — On August 2d, a boiler exploded at the Wheeling Steel Works, in Benwood, near Wheeling, W. Va. During the remodeling of the steel works recently, many new boilers were placed in the plant, but several of the old ones were left, the company thinking that they could be used for a time. It was one of these that exploded. The explosion could not have occurred at a more fortunate time, as the men were just changing turns. The day turn had just left its work and the night one was coming on. This is probably the reason that no lives were lost. Only a few minutes before the accident the fireman had fired the boiler that exploded, and he was at work on the next battery when the crash came. Pieces of the boiler were thrown through the iron roof, and far beyond the mill.

(169.) — A boiler exploded on August 2d in Edward Elliott's mill in Wamsley, Ohio, killing the proprietor and his brother, Charles Elliott, and injuring several employes.

(170.) — On August 2d a threshing-machine boiler exploded on a farm two miles east of Dahlgren, Ill. John Miller, engineer, and two boys, sons of John Underwood, were killed outright, and William Cremeens and Elmer Hook were fatally injured. Four other men also received injuries.

(171.) — By the explosion of a saw-mill boiler, ten miles west of Milan, Mo., on August 3d, John West, engineer, was killed, and two men named Scott and another whose name is West were scalded so badly that they cannot possibly recover.

(172.) — On August 4th the boiler of Frank Vesseli's threshing machine exploded at Montgomery, Minn. As the explosion occurred at lunch time nobody was killed, but seven stacks of wheat and the separator were burned.

(173.) — A small heating boiler exploded in Reading, Pa., on August 4th, doing some damage, but fortunately injuring nobody.

(174.) — On August 4th, while Ira Palen was threshing at the farm of John Franklin, near Jackson, Mich., the boiler of his machine exploded, scattering fire in all directions. The barn, wagon, sheds, tools, hay, and grain, and three horses were burned. The fire spread so rapidly that the men on the straw stack could get down only by rushing through the flames. Mr. Franklin was struck by pieces of the boiler and badly injured about the legs and side.

(175.) — The dredge *Philadelphia*, belonging to the American Dredging Company, was sunk off the foot of Walnut Street, Philadelphia, on August 7th, by the explosion of her boiler. Charles Warner, mate, was killed, and Andrew Anderson, engineer of the dredge, was scalded and bruised so severely that he died four days later. Edward Ramsey, mate, Prince Swain, steward, Alfred Bunting, a government inspector supervising the work of dredging, and John Tantau and William Wilkinson, workmen, were all more or less severely injured. Inasmuch as the daily press has repeatedly stated that "the boiler, which was regularly inspected by the Hartford Steam Boiler Inspection and Insurance Company, was pronounced all right at the last inspection," we deem it proper

to say that this is a mistake. We had neither inspected nor insured this boiler. Mr. Washington Jones, a director of the Dredging Company, testified before the coroner, concerning this point, as follows: "All the dredges but this one had been inspected and insured by the Hartford company. . . . This one was a recent purchase. The other dredges had been classed together, and it was hardly thought worth while to do so with this one, as it was in pretty good condition when it was acquired [by the Dredging Company]."

(176.) — On August 9th, as a steam traction thresher was being run along the road in New Sewickley township, near Freedom, Pa., the boiler of the machine exploded and seriously injured the owner, Samuel Wagner of Butler county. Mr. Wagner's skull was fractured and he was otherwise injured. It is believed that he will die.

(177.) — A threshing machine belonging to W. N. Bowers was destroyed by the explosion of the boiler, on August 9th, about four miles north of Zanesville, Ohio. The explosion occurred about two o'clock in the morning, the fires having been banked the night before, so that there might be no delay in starting up the next day.

(178.) — William Oakes, Jr., and George McQuality were seriously scalded on August 9th, by the explosion of a boiler at the Oakes Novelty Works, Decatur, Ill.

(179.) — The boiler of a steam grist mill belonging to Hosea Quimby of Easton, Miss., exploded on August 11th, blowing the mill to atoms. Cornelius Wershoff was slightly injured about the head and arms, and Peter Wershoff was very badly hurt about the head, and was rendered unconscious. It was marvelous that they were not killed outright. The property loss is variously estimated at from $7,000 to $12,000.

(180.) — On August 13th a steam purifier at the Louisville Electric Light Company's plant, Louisville, Ky., exploded, killing Edward Land and dangerously injuring Adolph Schwartz. Charles Wilson was blown through a roof, but escaped with slight injuries.

(181.) — The Rev. J. A. Aspinwall of Washington met with a serious accident on August 15th, near Shelter Island, L. I. A tube failed in the boiler of his steam yacht *Vanish*, while she was racing the *Palos*, owned by Mr. J. B. Edson. The engineer jumped overboard, but not before he had received serious burns and scalds. Mr. Aspinwall was badly burned about the face, hands, and legs, and at last accounts it was not known how serious his injuries might prove. The *Vanish* was built a year ago, and this is the second accident of a serious nature that has happened to her.

(182.) — A young man named Vaughn was fatally injured on August 16th, by the explosion of a boiler in Coventry, near Akron, Ohio.

(183.) — On August 16th a boiler exploded in the Brandeberry mill in Berwick, near Tiffin, Ohio. The mill was wrecked and considerable property in the neighborhood was destroyed. The engineer was at some distance from the mill, and nobody was injured.

(184.) — A small boiler exploded in a cigar factory in Norristown, Pa., on August 16th. Nobody was hurt, as the employes were nearly all at dinner. The damage was small.

(185.) — The boiler of a threshing machine belonging to a man named Reullard, at Georgetown, near Moorhead, Minn., exploded on August 18th. Three men were badly scalded, and one of them is not expected to live.

(186.) — At Medaryville, Pulaski County, Ind., two men lost their lives, on August

18th, by the explosion of the boiler of a threshing machine. August Sitkey, the engineer, was scalded to death, and John Cox was killed by flying pieces of the wrecked boiler. Peter Cox also received injuries that may prove fatal.

(187.)— Levi Boller and his son, Harry Boller, were instantly killed on August 20th, by a boiler explosion in Perry, near Elwood City, Iowa. Logan McElvaine was also injured so seriously that he died a day or two later. The boiler was blown 400 feet away, and the building in which it stood was completely wrecked.

(188.) — The boiler at Baker's mill, four miles northeast of Bagwells, Red River County, Texas, exploded on August 20th, instantly killing two men named Roberts and Horton. Mrs. Eli Matney was dangerously hurt, a flying missile striking her on the side of the face, crushing her cheek bone and tearing away a piece of flesh. Mrs. Baker, Eli Matney, and a man named Moore were more or less severely hurt. One section of the boiler struck Mr. Baker's residence, completely demolishing it. Fortunately, there was no one in the house at the time.

(189.) — A threshing-machine boiler exploded on August 20th, on the farm of H. A. Winan, eight miles north of Casselton, N. D. The engineer is said to have been badly hurt, and Isaac Milner, a prominent farmer, was also seriously injured.

(190.) — Another threshing-machine boiler exploded on August 21st, in the same neighborhood. This machine was owned by George Fowler & Sons, who were threshing on the Dill farm, near Durbin, N. D. Engineer J. M. Campbell was killed, and Fireman Peter Standard was very badly scalded, and it is said that he cannot live.

(191.) — On August 21st a threshing-machine boiler exploded near Byron, Ill. Hiram Burksmith was blown to pieces and instantly killed. Andrew Roos had both legs blown off, and died a short time afterwards. Hiram and John Brass, Henry Ehmen, Charlie and John Luenka, and Edward Nuess, all boys ranging from 9 to 16 years of age, were badly scalded and maimed. The two Luenka boys have since died, and Dr. Clinton Helm, one of the attendant physicians, stated that three of the remaining victims cannot survive. The thresher was completely destroyed. The fly-wheel of the engine was picked up 500 feet away, and pieces of iron were blown through the side of a house 20 rods distant.

(192.) — Still another threshing-machine boiler exploded, on August 22d, in North Dakota, on Edward Jensen's farm, near La Moure. John Lind, a well-known resident of the county, was killed outright, and Louis Berg, the fireman, was blown 300 feet, and was dead when found. Frank Welsh, a band cutter, was badly cut. Orrin Clark, engineer, had his left shoulder dislocated and his left arm broken, and received scalds. H. M. Townsend had several ribs broken and was otherwise badly bruised. Gilbert Johnson received a bad cut on the side of the neck. Two horses were also killed.

(193.)— A slight boiler explosion occurred, on August 23d, in the office of the *Journal*, at Ithaca, Mich. Some slight damage resulted, but nobody was hurt.

(194.) — A boiler exploded, on August 23d, in Blenheim, near Baltimore, Md., killing Andrew Hammond and severely scalding Christopher Cochran.

(195.) — On August 18th, a boiler exploded in Sites & Kellenberger's flouring mill, in Newark, Ohio. Frank Gates was seriously scalded about the face, neck, and hands.

(196.) — By the explosion of a boiler in Kramer's mill, Frankfort, Ind., on August 24th, John Vermillion and William Jackson were killed. A section of the boiler demol-

ished a cooper shop near by, and injured a workman named Barto. A number of other persons received slight injuries from flying fragments. The mill was completely destroyed. It is said that Mr. Kramer estimates his property loss at $10,000, and the damage to surrounding property is said to have been $3,000.

(197.) — A threshing-machine boiler, belonging to Nathan Keeney, exploded near Atchison, Kan., on August 24th. We did not learn further particulars.

(198.) — On August 26th, as Herbert A. Beidler and a party of friends were taking a trip around Lake Geneva, Wisconsin, on his steam yacht *Cygnet*, a flue failed in the boiler, and the engineer, George Smith, was terribly and perhaps fatally burned.

(199.) — On the morning of August 29th, while a steam launch belonging to the new cruiser, *Cincinnati*, was on the way to Greenport, L. I., to get the mail, an accident of some kind occurred to the boiler, and the engineer was scalded. Late in the afternoon of the same day, while the launch was steaming in from Gardiner's Bay, two of her flues failed, and the engineer was badly scalded again.

(200.) — A threshing machine boiler, belonging to John H. Miller, exploded on August 30th, five miles west of Muncie, Ind. There were about fifty men in the vicinity, but, marvelously, no one was injured in the least.

(201.) — On August 30th, a boiler exploded at Stony Brook, near Fergus Falls, Minn. Hans Harvig, engineer, was badly crushed, and died instantly. His father, Knute Harvig, who was firing at the time of the explosion, was struck in the head by a flying fragment and instantly killed. Tollof Anderson, who was 75 feet away, was struck in the thigh by a piece of iron, and injured so badly that he died four hours later. H. T. Harvig was badly scalded, but may recover. Both heads of the boiler were blown out. The cause of the explosion is not known.

(202.) — A serious accident occurred on August 30th, in connection with the exposition at Hornellsville, N. Y. The boiler of a small engine used to drive a cream separater exploded, and a Mr. Carpenter, who happened to be near by, was seriously if not fatally injured about the face and groin. Several other persons were seriously burned about the face and hands. Pieces of the boiler were found a quarter of a mile away.

(203.) — One of the two large boilers at the West Washington street power house of the Citizens' Street Railroad Company, Indianapolis, Ind., exploded on August 31st, causing an estimated damage of $6,000, temporarily crippling the street-car system, and slightly injuring Michael Egan, John Gallagher, and a Mr. Murphy. The walls of the building were considerably injured, holes ten feet wide were opened in the sheet-iron roof, and the iron smoke-stack, 75 feet high, was tipped into a dangerous position.

His Inspiration.

"Horrors, what an obscure hand you write!" said the editor to the new space writer, as he turned in a bit of poetry.

"Oh, it's plain enough," interjected the poet hastily. "The rhymes and the meter will help the compositor out, and there'll not be the least bit of trouble if they follow copy." And the copy went hastily up to the composing room. . . .

"Say-ay, what dod-gasted chump's been sendin' in his Chinese laundry bill for copy?" wildly yelled out Slug 10, wiping a sudden burst of perspiration from his forehead and glaring at his last "take." "I can't make head or tail out of this thing."

"Well, Chinese or no Chinese," cried the hurrying foreman, "make whatever you can out of it, and snag it up in mighty short order, for we're late now."

And the type fairly jumped from the case into the stick. . . .

"Good Cæsar!" gasped the proof-reader, clutching at his brow, "are my eyes failing, or is this a premonition of nervous prostration?" Then he rubbed his eyes and stared. "By the gods! either I've got the blind staggers or Slug 10's on a royal toot!"

At that instant a scream came down the spout: "Rush that proof along, for heaven's sake. We're late."

The proof-reader groaned, galloped down the column, hesitated, and then desperately thrust the slip into the tube, huskily murmuring, "I compared it with the copy, and that's as near as I can get to Hebrew these days." . . .

That night the new space writer hurriedly wrapped up and addressed a copy of the issue, without a glance, and dropped it into the mail with this brief note:

"My onliest Sweet and Dearest Marie: I send you a number of the Sunday supplement containing my little poem. Your face was an ever present inspiration to me when I wrote, and happy thoughts of you inspired every sentence. Here you will find expressed what I have ever felt toward you, but have hardly dared to voice before. Till death, etc."

Miss Marie Cortlandt van Clifton glanced through the tender note, blushed with pleasure, and, hurriedly opening the paper, read:

TO MARIE.

When the breeze from the blue-bottle's blustering bliss
Twirls the toads in a tooroomaloo,
And the whiskery whine of the wheedlesome whim
Drowns the roll of the rattattatoo,
Then I dream in the shade of the shally-goshee,
And the voice of the ballymolay
Brings the smell of stale poppy-cods blummered in blue
From the willy-wad over the bay.

Ah, the shuddering shoe and the blinketty blanks
When the punglung falls from the bough
In the blast of a hurricane's hicketty-hanks
On the hills of the hocketty-how!
Give the rigamarole to the clangery wang,
If they care for such fiddlededee;
But the thingumbob kiss of the whangery bang
Keeps the higgledy-piggle for me.

L'ENVOI.

It is pilly-po-doddle and aligobung
When the lolly-pop covers the ground;
Yet the poldiddle perishes punkety-pung
When the heart jimmy coggles around.
If the soul cannot snoop at the gigglesome care,
Seeking surcease in gluggety-glug,
It is useless to say to the pulsating heart,
"Panky-doodle ker-chuggety-chug!"

And the new space writer and Miss Marie Cortlandt van Clifton are not now engaged.—*Cincinnati Commercial Gazette.*

DR. PULSER: "Did you remove old Bonder's vermiform appendix?"
DR. CUTTER: "Yes."
DR. PULSER: "And was there anything in it?"
DR. CUTTER: "Yes; a cold two-fifty."—*Life.*

The Locomotive.

HARTFORD, OCTOBER 15, 1894.

J. M. ALLEN, *Editor.* A. D. RISTEEN, *Associate Editor.*

THE LOCOMOTIVE *can be obtained free by calling at any of the company's agencies.*

Subscription price 50 cents per year when mailed from this office.

Bound volumes one dollar each. (Any volume can be supplied.)

Papers that borrow cuts from us will do us a favor if they will mark them plainly in returning, so that we may give proper credit on our books.

BY an unfortunate clerical error, the total number of dangerous defects found by our inspectors during the month of July was stated (in our September issue) to have been 1,097. It should have been 1,102, as an addition of the column in question will show.

THE following data concerning the steam power of the world are quoted by our esteemed contemporary, the *Safety Valve*. They are said to have been given out by the bureau of statistics in Berlin: Of the steam engines now working, four-fifths have been constructed during the last twenty-five years. France has 49,590 stationary and locomotive boilers, 1,850 boat boilers, and 7,000 locomotives; Germany, 59,000 land boilers, 1,700 ship boilers, and 10,000 locomotives; Austria, 12,000 boilers and 2,800 locomotives. The working steam engines of the United States represent 7,500,000 horse-power; Germany, 4,500,000 horse-power; France, 3,000,000; Austria, 1,500,000. This estimate does not include the locomotives, whose number in the world is 105,000, representing a total of 3,000,000 horse-power. The world's steam engines, therefore, aggregate more than 26,000,000 horse-power, equivalent approximately to the work of 1,000,000,000 men.

What is a Heat Unit?

When, in ordinary conversation, a person uses the word "heat," there is often some uncertainty about the precise meaning that he intends to convey by it. This uncertainty arises partly from the many figurative meanings of the word, but principally from a confusion of "heat," properly so-called, with "temperature." For example, we speak of the "heat of the day," meaning that part of it which is hot — *i. e.*, the middle of the day. Again, we speak of the "heat of a furnace,"— meaning, really, the *temperature* of the furnace. In the expression "animal heat," on the other hand, the word "heat" is possibly used in its strict sense, and we understand it to mean a *quantity* of some sort or other, which could be measured just as definitely as wood or potatoes can be, if we could only devise some appropriate unit by which to perform the measurement.

In order to get a somewhat clearer idea of the difference between heat and temperature, let us consider a tub of hot water. A thermometer immersed in this water reads (say) 200° Fah.; and under these circumstances many persons would say that the water "contains 200 degrees of heat." Now nothing could be more misleading nor more erroneous than such a statement as that. It should be observed that the only thing we have determined is the *temperature* of the water; and the thermometer would read just

the same whether the tub contained a pint of the water, or 40 gallons of it, or a thousand oceans of it. If one should find that a thermometer plunged in the Atlantic Ocean gave just the same reading as a similar one immersed in a gill measure, he surely would not say that the gill of water in his hand contained as much *heat* as the whole Atlantic Ocean. His observation would indicate that the *temperatures* of the two were alike, but that is all.

In order to determine the amount of *heat* in a given body of water, we must first decide upon some convenient *unit of heat*, and then we must find out how many of these units would be required to raise the given mass of water from the freezing point to the given temperature. For example, we might adopt, as our unit of heat, the heat required to melt one pound of ice; and we could then determine how many pounds of ice the given mass of water could melt, in cooling from the observed temperature down to the freezing-point. This method of procedure is quite satisfactory for laboratory purposes, and various forms of apparatus have been devised for putting it into practice, some of which enable us to measure quantities of heat with great precision. Valuable as these "ice calorimeters" are in the laboratory, they are of little or no use to the engineer, because ice is often expensive and difficult to obtain, and because the apparatus necessary to ensure accuracy in measuring large quantities of heat by this method would be so cumbersome that it could not be transported from place to place.

For general use in engineering we are obliged, therefore, to adopt some other unit for heat-measurement. We might, for example, define a "unit of heat" as the quantity of heat required to raise the temperature of a pound of some given substance one degree; and, in fact, this is the kind of unit that is actually used in practice. We could base the proposed unit on any substance we choose, but as water is both cheap and convenient, and as it can nearly always be obtained in a condition of reasonable purity, it has been adopted by universal consent; and a "heat unit" is defined to be that quantity of heat which will raise the temperature of one pound of water one degree.

Before we could adopt any such general definition as this, we should have to find out whether or not it takes the *same* quantity of heat to raise the temperature of a pound of water from (say) 39° to 40°, that it does to raise it from (say) 210° to 211°. If this is not the case, it will be necessary to modify our definition of a "heat unit" to the extent of specifying at what temperature the pound of water is to be taken. To guard against a possible ambiguity of this kind, some writers define a heat unit as "the quantity of heat required to raise the temperature of a pound of water from 39° to 40°;" while others define the temperature range to be "from 32° to 33°," and others "from 59° to 60°."

In order to judge of the importance (or unimportance) of specifying the temperature of the water in defining the heat unit, let us examine some of the experimental data that have been obtained relative to this point. If the heat required to raise the temperature of a pound of water one degree were the same, all the way from the freezing point to the boiling point, it would follow that if we should stir together two pounds of water, one of which is at 212° and the other at 32°, the temperature of the mixture would be $\frac{212° + 32°}{2} = 122°$; and conversely, if the temperature of the mixture is found to be *different* from 122°, we should know that the quantity of heat required to raise the temperature of a pound of water by one degree is *not* the same at all points on the thermometer scale. Careful experiments, performed after taking all possible precautions against loss of heat by radiation and conduction, have shown that when a pound of water at 212° is mixed with a pound of water at 32°, the temperature of the mixture

is 122.29°. This shows that the quantity of heat required to raise the temperature of a pound of water one degree is *not* the same at all points of the thermometer scale, but it indicates, at the same time, that the total variation between the freezing point and the boiling point is very slight. Similar experiments, made by mixing water at other temperatures, give this same result; and hence we conclude that although a "heat unit" is not the same at all temperatures, the variation in its value is so slight that for most purposes it can be neglected. In calculating tables of the properties of steam and water, allowance is made for the fact that the "specific heat" of water is not the same at all temperatures; but in all the ordinary work of testing boilers and engines, and laying out steam-plants and heating-systems, it is customary to consider the specific heat of water to be *constant*; and the "heat unit" is defined simply as "the quantity of heat that will raise the temperature of one pound of water one degree."

When we say that a pound of steam, in condensing, gives out 967 heat units, we merely mean that it gives out an amount of heat that would be sufficient to raise the temperature of 967 pounds of water 1°, or 96.7 pounds of water 10°, or 9.67 pounds 100°, etc. Similarly, when we say that a pound of good coal gives out 14,000 heat units when burned, we mean that each pound of the coal can heat 14,000 pounds of water 1°, or 1,400 pounds 10°, or 140 pounds 100°, etc. And finally, when we say that the "mechanical equivalent of heat" is 779 foot-pounds, we only mean if a weight of 779 pounds should fall one foot, the work it would do would be just sufficient to raise the temperature of a pound of water 1°; and, conversely, if we could utilize (by means of a steam engine or otherwise) all the heat that a pound of water gives out when it cools 1°, this heat would be just sufficient to raise a weight of 779 pounds through a height of one foot.

The Recent Eruption of Kilauea.

This great volcano has been active for several months past, the principal characteristic being a remarkable rise and fall of melted lava within the crater. L. A. Thurston gives the following among other particulars in the Pacific *Commercial Advertiser*. In March, 1894, the lava had risen almost to the top of the crater, the rise being 447 feet in 19 months.

On the evening of July 6th a party of tourists found the lake in a state of moderate activity, the surface of the lava being about twelve feet below the banks. On Saturday, the 7th, the surface of the lake raised so that the entire surface was visible from the Volcano House. That night it overflowed into the main crater, and a blow hole was thrown up some 200 yards outside and to the north of the lake, from which a flow issued. There were two other hot cones in the immediate vicinity which were thrown up about three weeks before. On Sunday, Monday, and Tuesday, July 8th, 9th, and 10th, the surface of the lake rose and fell several times, varying from full to the brim to 15 feet below the edge of the banks.

On the morning of the 11th the hill was found to have sunk down to the level of the other banks, and frequent columns of rising dust indicated that the banks were falling in. The lake had fallen some 50 feet, through the escape of the lava by some subterranean passage, and the wall of the lake formed by the hill was falling in at frequent intervals. The lava in the lake continued to fall steadily, at the rate of about 20 feet an hour from 10 o'clock in the morning until 8 in the evening. There was scarcely a moment when the crash of the falling banks was not going on. As the level of the

lake sank, the falling rocks of the banks, undermined by the escape of the lava, caused a constantly increasing commotion in the lake as they struck the surface of the molten lava in their fall. A number of times a section of the bank from 200 to 500 feet long, 150 to 200 feet high, and 29 to 30 feet thick, would split off from the adjoining rocks, and with a tremendous roar, amid a blinding cloud of steam, smoke, and dust, fall with an appaling down-plunge into the boiling lake, causing great waves and breakers of fire to dash into the air, and a mighty "ground-swell" to sweep across the lake, dashing against the opposite cliffs like storm waves upon a lee shore. Most of the falling rocks were immediately swallowed up by the lake, but when one of the great down-falls referred to occurred, it would not immediately sink, but would float off across the lake, a great floating island of rock.

As the lava subsided, most of the surrounding banks were seen to be slightly overhanging, and as the lateral support of the molten lava was withdrawn, great slices of the overhanging banks on all sides of the lake would suddenly split off and fall into the lake beneath. As these changes took place the exposed surface, sometimes 400 feet across and upward, would be left red hot, the break, evidently, having taken place on the line of a heat crack which had extended down into the lake. From 6 to 8 o'clock the entire face of this bluff, some 800 feet in length and over 200 feet in height, was a shifting mass of color, varying from the intense light of molten lava to all the varying shades of rose and red to black, as the different portions were successively exposed by a fall of rock and then cooled by exposure to the air. During this period the crash of the falling banks was incessant. Sometimes a great mass would fall forward like a wall; at others it would simply collapse and slide down, making red-hot fiery landslides; and again enormous boulders, as big as a house, singly and in groups, would leap from their fastenings and, all aglow, chase each other down and leap far out into the lake.

The awful grandeur and terrible magnificence of the scene at this stage are indescribable. As night came on, and yet hotter recesses were uncovered, the molten lava which remained in the many caverns leading off through the banks to other portions of the crater began to run back and fall down into the lake beneath, making fiery cascades down the sides of the bluff. There were five such lava streams at one time. The light from the surface of the lake, the red-hot walls, and the molten streams lighted up the entire area, bringing out every detail with the utmost distinctness, and lighted up a tall column of dust and smoke which arose straight up. During the entire period of the subsidence the lava fountains upon the surface of the lake continued in action, precisely as though nothing unusual was taking place. — *Scientific American.*

The late Bishop Selwyn of New Zealand and Melanesia was well known during his university days as a devotee of the noble art of self-defense. He incurred a great deal of animosity from a certain section in New Zealand, owing to his sympathy with the Maoris during the war. One day he was asked by a rough in one of the back streets of Auckland if he was "the Bishop who backed up the Maoris." Receiving a reply in the affirmative, the rough, with a "Take that, then," struck his lordship in the face.

"My friend," said the bishop, "my Bible tells me that if a man smite thee on one cheek turn to him the other," and he turned his head slightly the other way. His assailant, slightly bewildered and wondering what was coming next, struck him again. "Now," said his lordship, "having done my duty to God, I will do my duty to man," and taking off his coat and hat he gave the anti-Maori champion a most scientific thrashing.— *Home Journal.*

Incorporated 1866.

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The Locomotive.

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Concerning Cast-iron Flanges.

The large mouth-pieces of rendering tanks and upright bleachers are usually made of cast-iron, and are provided with flanges through which pass the bolts that hold the covering plate in position. It is to these flanges that we wish to call attention in the present article.

Consider, for example, the mouth-piece illustrated in Fig. 1. The internal diameter of the casting, in this case, was thirty inches, and a steam pressure of 100 pounds to the square inch was carried, making the total load on the cover-plate some 71,000 pounds. This load was transmitted to the flange of the casting by bolts, two of which are shown in the illustration. There was a sufficient number of bolts to withstand the load safely, and the main body of the casting was also stout enough to be safe. We desire to call

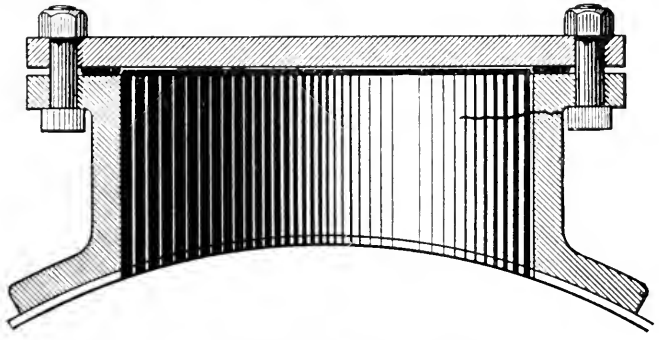


FIG. 1. — A CAST-IRON FLANGE WITHOUT BRACKETS.

attention, however, to the fact that since the cover-bolts are not in line with the body of the casting, the strain in the flange is neither a simple shear nor a simple pull. In fact, the flange is in the condition of a beam loaded at one end and fixed at the other; and therefore the horizontal strain at the root of the flange will be a *tension*, and its magnitude can be easily computed by means of the usual rules for beams. But the strain at the root of the flange is not due to the steam pressure alone, for in turning up the nuts on the bolts so as to secure a tight joint we shall produce a very material addition to the strain on the flange, which we shall have to take into account. By making certain reasonable assumptions concerning the strain on the bolts due to screwing up the nuts, we find that in the case under consideration the tensile strain on the main casting at the root of the flange was about 4,100 pounds. We cannot safely rate the tensile strength of cast-iron higher than 15,000 pounds, and hence the factor of safety in the present instance is only about $3\frac{2}{3}$, whereas it ought to be about 10. The packing being all within the line of bolts, it is easy to see that if a slight leakage should occur, and the

attendant should attempt to check it by screwing up the nuts unreasonably, the tensile strain on the casting would be still further increased, and the actual factor of safety correspondingly reduced. It will be evident from what has been said already, that the flanges of large cast-iron mouth-pieces should be carefully considered both by the designer and by the builder, even if the casting were equally sound throughout. It is

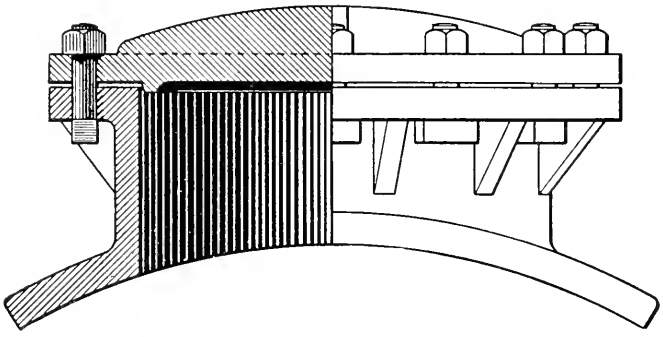
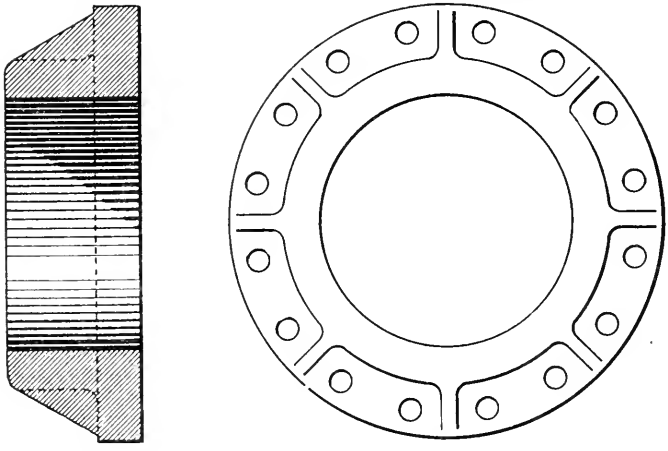


FIG. 2. — A PROPER CONSTRUCTION FOR CAST-IRON MOUTH-PIECES.

well-known, however, that castings are liable to be spongy at the root of the flange, where our analysis shows them to be weakest; and this fact should also be considered in designing and constructing them.

Lest any of our readers should fancy that we have exaggerated the dangers of cast-iron flanges, let us say that we have known flanges *three inches thick* to break at the root



FIGS. 3 AND 4.— DESIGN FOR A CAST-IRON FITTING FOR A TEN-INCH STEAM PIPE.

from the causes we have described. We also have another case in mind in which an incipient crack occurred at the root of the flange of the mouth-piece of a digester carrying 100 pounds pressure, and although it was promptly discovered, it had extended along the mouth-piece for a distance of *twenty inches* (as indicated by the irregular line in Fig. 1), before the pressure in the digester could be reduced.

In order to provide against the breaking of cast-iron flanges care should be taken to make them abundantly thick; or, which we consider a better plan, they may be made with *brackets* running from the flange to the body of the casting at frequent intervals, as shown in Fig. 2. The cover may be flat, if it is made thick enough, but it is much better to provide ribs on the upper side of it, as in Fig. 2. Such ribs possess great stiffening power and add much more to the strength of the cover than the same amount of metal would if distributed in any other way. When the covers of digesters and bleachers have to be frequently removed, it is usual to slot the bolt-holes so that the bolts can be removed by merely loosening the nuts. They are also frequently so arranged that each bolt turns about a horizontal pin that passes through holes in a pair of parallel brackets cast on the body of the mouth-piece. The discussion of the features is reserved for a future issue, however, as we are here concerned merely with the strength of cast-iron flanges.

The reasoning that we have given in connection with mouth-piece flanges is also applicable to the cast-iron flanges used in connecting large steampipes that are designed to carry heavy pressures. Figs. 3 and 4 show a front view and a sectional view of a bracketted flange connection as designed for a ten-inch steam main, and a design substantially similar may be used for other sizes of pipe.

Inspectors' Report.

SEPTEMBER, 1894.

During this month our inspectors made 7,824 inspection trips, visited 15,253 boilers, inspected 6,542 both internally and externally, and subjected 652 to hydrostatic pressure. The whole number of defects reported reached 11,292, of which 1,195 were considered dangerous; 31 boilers were regarded unsafe for further use. Our usual summary is given below:

Nature of Defects.	Whole Number.	Dangerous.
Cases of deposit of sediment,	900	39
Cases of incrustation and scale,	1,918	59
Cases of internal grooving,	78	13
Cases of internal corrosion,	587	28
Cases of external corrosion,	805	45
Broken and loose braces and stays,	159	27
Settings defective,	432	43
Furnaces out of shape,	407	19
Fractured plates,	255	39
Burned plates,	252	26
Blistered plates,	245	17
Cases of defective riveting,	1,440	114
Defective heads,	123	19
Serious leakage around tube ends,	1,895	409
Serious leakage at seams,	508	48
Defective water-gauges,	402	67
Defective blow-offs,	168	54
Cases of deficiency of water,	20	5
Safety-valves overloaded,	84	18

Nature of Defects.	Whole Number.	Dangerous.
Safety-valves defective in construction,	73	20
Pressure-gauges defective,	413	34
Boilers without pressure-gauges,	49	49
Unclassified defects,	79	3
Total,	11,292	1,195

Boiler Explosions.

SEPTEMBER, 1894.

(204.)—On September 1st, a boiler exploded at McKay, Dingman & Co.'s oil well near Titusville, Pa. Jacob F. Toy was instantly killed, and three other men, who were in the derrick, had narrow escapes. According to the Titusville *Herald*, "the boiler had just been filled and fired up, and while the men were at work about the well and not using the engine, the steam began blowing off through the safety-valve. Not wishing to waste water and fuel, one of the men employed about the well took a pair of tubing tongs and hung them on the end of the safety-valve lever and stopped the valve from allowing the steam to escape. The work at which the men were engaged lasted longer than they expected, the tongs were forgotten, and the steam ran up so high that the boiler was blown to pieces by the over-pressure. The fact of weighting down the safety-valve lever was forgotten until some days after the explosion, and for that reason no evidence of the fact was given before the coroner's jury at the inquest."

(205.)—A boiler exploded with terrible force, on September 1st, in Stanton's Riverside laundry at Janesville, Ill. The laundry was in the basement of the Mechanics' and Merchants' Savings Bank. The explosion demolished the entire rear end of the building, destroying not only the laundry but the machinery in an adjoining dye-house. Kittie Connors, Bertha Greenwald, Gustave Haise, Julia Kinna, A. A. Kapelsky, and Cornelius Roberts were injured. One account of the explosion says that "the engineer had gone out after a pail of water just before the accident, returning in time to get a brick thrown through his hat." The property loss amounted to some thousands of dollars.

(206.)—On September 3d a boiler exploded in Sabina, Ohio, killing James Robinson, and frightfully scalding William Mercer, who is not expected to recover. Parts of the boiler were driven through J. W. Hill's house, three hundred yards away. It is reported that the boiler had no steam gauge, and that the safety-valve was wired down.

(207.)—A boiler exploded, on September 4th, in Hutchispon's saw-mill, near Frankfort, Tenn. George Taylor was killed outright, and several other men were injured.

(208.)—J. A. Gagnon's mills, across the St. Maurice river from Three Rivers, Quebec, were wrecked, on September 7th, by a boiler explosion. Samuel Beaumier was instantly killed, and his body was found a hundred feet from the scene of the explosion. Philip Gaudet, Daniel Loranger, Napoleon Sanstette, Philip Mercier, Dolphus Rocheleau, Joseph Carboneau, and a father and son named Murdock, were injured.

(209.)—A boiler exploded, on September 8th, in the Warwick tool works, Wheeling, W. Va. The damage was slight, as the pressure, at the time of the explosion, was only twenty pounds.

(210.)—While Charles Cory was pumping an oil well near Bradford, Pa., on September 8th, he was instantly killed by the explosion of a boiler.

(211.)—A cotton-gin boiler exploded, on September 8th, at Una, Texas. Nobody was hurt.

(212.)—There was a boiler explosion, on September 11th, in William Moberly's flouring mill, on Paint Lick, near Richmond, Ky. Thomas Moberly was scalded internally, and cannot live. William Marr and two other men were also painfully injured.

(213.)—On September 14th, a boiler exploded in the gas house at New Castle, Pa. The boiler was hurled through the roof, and landed in a field about 60 feet away. The building was badly wrecked. Several men were working in the gas house at the time, but all escaped injury.

(214.)—On September 14th, the new passenger steamer *Unique* left Port Huron, Mich., for Detroit, on her second trip. When she was opposite St. Clair a flue failed in one of her boilers. The fireman, James Primrose, was fatally scalded.

(215.)—A boiler exploded, on September 19th, at the Harold Mill Company's lumber mill on Conecuh river, six miles east of Brewton, Ala. It is said that two hundred thousand feet of lumber were destroyed in the fire that followed.

(216.)—On September 19th, the steam boiler attached to a portable feather renovator, operated by Messrs. Seely & Mott, blew up on the street at South Haven, Mich., throwing both Seely and Mott some distance. Mr. Seely was seriously, and perhaps fatally, injured.

(217.)—A boiler exploded, on September 20th, in Frank Carver's mill, near Sulphur Springs, Ark. William Ward was killed outright. George Carver, a brother of the owner of the mill, was badly cut on the face and legs; Engineer Locial was dangerously scalded; one boy and four men, whose names we have not learned, were badly cut and burned. Another man had his head blown off, and seven more were fatally injured. The mill was entirely demolished, and the noise of the explosion was heard for miles. The property loss was about $10,000.

(218.)—Engine No. 89, drawing a freight train of thirty cars on the Delaware railroad, exploded its boiler, on September 20th, when about a mile and a half south of Harrington, Del. The crown-sheet failed, and the fire was blown out of the furnace door. All the coal was blown out of the tender, and with such violence that part of it was driven through the end of the first freight car. Engineer John Parsons, Fireman Albert C. Dunn, and Brakeman C. E. Ellingsworth were injured. Brakeman Charles Lee jumped from the cab and escaped injury.

(219.)—On September 20th, a boiler exploded in Boyd's saw-mill, killing Redfield Reid, Nathan Henneck, and George Martin. Several others were badly injured, and all the buildings in the neighborhood were demolished.

(220.)—A saw-mill boiler, six miles east of Florence, Kan., exploded on September 21st. Engineer Smith had his collar bone broken and his shoulder badly torn.

(221.)—On September 21st, a boiler exploded in W. H. Kimball's mill, in Winder, Ga. John Hill received a bad fracture of the skull, together with various cuts and bruises, and it is believed that he will die. Three other men were severely scalded.

(222.)—On Friday, September 21st, Cyrus Rissmiller and Harrison Hahn of Wind Gap, Pa., hired a cider press from Luther Miller. Next morning Hahn and Howard

Hildebrand fired up the boiler, and were about to begin operations, when suddenly the boiler exploded, and the air was immediately alive with machinery and bits of iron. Hahn, who was standing near by, was deposited in an adjoining cabbage patch. Hildebrand was seriously scalded about the head and neck.

(223.) — The boiler head of a locomotive on an east-bound train blew out, on September 24th, as the train was passing through the snow sheds near Blue Canton, Cal. Engineer Goddard and Fireman Lipscomb were severely injured, and Lipscomb died a few hours later.

(224.) — A boiler exploded, on September 24th, in a meat shop in Marion, Wis. Nobody was hurt.

(225.) — On September 24th, a cast-iron header failed on one of the safety boilers of the Consumers' Ice Company in San Francisco, Cal. Nobody was injured.

(226.) — A heating boiler exploded in the court house at Mercer, Pa., on September 25th. The damage was insignificant.

(227.) — By the explosion of a threshing-machine boiler on William Cain's farm at Crystal, N. D., on September 25th, William Hawthorne, Christopher Burns, F. A. Barranger, and Nicholas Phillipps were killed outright, and Charles Shepherd and Alexander Proux were so badly injured that they died shortly afterwards. George Proux, Morris Gettry, and Thomas Morgan were also fearfully injured. Gettry's skull was fractured. W. Rice, H. Haeton, and Norman Montgomery received lesser injuries.

(228.) — Harrison Wilder's cotton gin, seven miles east of Calvert, Texas, was destroyed, on September 27th, by a boiler explosion. Wilder and two boys were killed.

(229.) — Four boilers exploded, on September 28th, at the Schuylkill colliery, near Mahanoy City, Pa. The boiler house was destroyed. Fortunately all the hands escaped injury. The breaker took fire, but was promptly extinguished.

(230.) — A slight boiler explosion occurred, on September 28th, at the Hubinger electric light plant in Keokuk, Iowa. Nobody hurt.

Machinery and Labor.

The nineteenth century man has good reason to be proud of himself, for he has wrought a greater change in the material and social aspects of the world than ever was seen in a thousand years before. It is true that there have been civilizations before his — some of them very splendid — but they were local and parochial compared with that which is now rapidly enveloping the globe. Even the achievements of the Roman Empire, extending over long centuries, did not equal those within the memory of living men. The past civilizations rested on two bases — intellect and military — sometimes one and sometimes the other predominating. These sufficed for creating great cities and communities, for evolving systems of law, and for organizing and controlling armies. But they did little towards freeing man from the curse of living by the sweat of his brow. Human muscles were nearly the sole source of mechanical power. The trireme was rowed by slaves, the mill was turned by women, editions of books were produced by the pen, and all manufactures were the result of heavy toil. It was only by enslaving whole nations that the refinement and luxury of Roman society was rendered possible. By skillful organization, and above all by the stern repression of wars and feuds, the labor of Europe was turned to the best account, and so civilization prospered. Its limit, however, was marked by the amount of work a man could do in a day. But

by the invention of the steam engine, this limit was swept away, and humanity was freed from the heaviest part of its burden of toil. No longer does the slave tug at the oar, the miner carry up the ore on his back, or the traveler tramp wearily from dawn to dark. But not only did the steam engine undertake the hard work of the world, but it begot machinery that rivals the best handicraft in skill, and exceeds it a thousandfold in production, rendering one man able to undertake the work of many. It is this relaxation from hard manual toil, and the ability to produce more than is needed to maintain life, that lies at the root of that wonderful development of our times.

A period of change always brings suffering to some, even if the general effect be one of great improvement. In the rearrangement of social conditions some of the old parts do not fit into the new scheme, and are flung out, or else need to be greatly altered before they can be utilized. At times during this century the changing conditions have caused immense suffering, which found expression in anti-machinery riots, Chartism, and other popular movements, and now some of these are being revived in a new form. In an introductory address, delivered by Mr. John Inglis to the Institution of Engineers and Shipbuilders in Scotland last Tuesday, there was a reference to a Hyde Park orator, who spoke of Labor as crucified between two thieves — Capital and Machinery. Little must the orator have known of the history of labor to refer to its present condition, with its powerful trade unions and an eight-hours bill looming in the near future, as crucifixion. Probably, however, as Mr. Inglis suggests, he was more intent upon using a sounding figure of speech than of finding one that represented the truth, and that all he wished to enforce was that the misery of labor was embittered by the presence of capital and machinery.

There is, unfortunately, no doubt that labor is passing through a period of trial, and that the pressure upon it will increase as we get farther into winter. It is only natural that at such a time men should cast about to find the reason, and that those with untrained minds should seize upon the first that comes to hand, and repeat it until it becomes accepted by persons like themselves. The proposition, that if it required two men to do the work now accomplished by one, there would be a greater demand for labor, appears so charmingly simple when launched with rhetorical skill at a popular gathering, that it is pretty sure to find a good deal of acceptance, and be the means of leading people into economic error. The mob orator has an immense advantage over the man that discusses such a question scientifically, in that he demands no thought on the part of his audience. At a time like the present, when many people are beginning to doubt the value of the greatest blessing — next to settled government — ever evolved by the human race, it is essential that those who are better informed should speak out, and we are glad to see that Mr. Inglis adopted the course we have persistently advocated of making his inaugural address the expression of his great experience and mature thought, instead of following the usual custom of giving a string of incomplete and unsatisfactory statistics.

He summed up the popularly alleged causes of the present slackness of demand for our wares, and of the abasement of ocean freights, under four heads, *viz.:* monometallism, labor disturbances, the private ownership of land and minerals, and over-production. The first three he dismissed very briefly. He has no faith in bi-metallism; he deplores industrial wars, but points out that, at any rate, they are an antidote to over-production; as for land tenure, he believes that the usages connected with the occupation of land have yet to be completely adapted to the new environment of which modern mechanical appliances are mainly the cause, and that this adaptation, like all radical changes, will probably continue to be attended by much suffering to individuals. To the fourth alleged

cause — over-production — he devotes greater space. In this relation he says: "The truth about the matter I believe to be that the condition of things, which we agree to call over-production, or depression of trade, is not primarily due to machinery, but, in a great measure, to the reckless borrowing by impecunious States, communities, and associations, encouraged by the imprudence of financiers, and the credulity of the public as to the powers of governments and other debtors to fullfil their obligations. The abnormal and unwarranted demand for goods from those put in easy possession of borrowed funds is rapidly met by the setting in motion of modern machinery — itself partly brought into existence by the necessity temporarily created. High prices become the rule, until the inevitable glut takes place, when there follows the revulsion to prices that are unremunerative. The fall in values is, perhaps, increased in rapidity by machinery, but the unwholesome stimulus is not immediately traceable to mechanical appliances." This explanation is more satisfactory to the capitalist than to the laborer, for the latter seldom reaps such a harvest during the good times as will carry him comfortably over the periods of depression. It is undoubtedly true that machinery does displace manual labor very often, and that it does not always produce such a lowering in price that the increased demand reinstates the men who have been superseded. Mr. Inglis finds from the census returns, by Messrs. Booth, Hobson, and Marshall, that while the output of textile goods has enormously increased, the proportion of labor employed in their production has continuously diminished. Again, while the rural population has declined but little, the number of persons engaged in agricultural labor has largely decreased, and this falling off began long before the comparatively recent fall in rents, and what is known as the decay of agriculture in this country. What has become of the persons that would, had the strict ratio been maintained, have followed these pursuits? Evidently they have turned to others, either old or new. Commercial pursuits, shopkeeping, transport, and other industries show an increase beyond their due proportions; shipbuilding afforded employment to 40 per cent. more persons in 1891 than 1881; the making of machinery and tools required an increase of 28 per cent. during the decade; those engaged in road traffic and in the industries connected with it show an increase; coal miners have grown in numbers 35 per cent. in ten years, while the output has only augmented 20 per cent. Of those released from manual labor, many have betaken themselves to professions. Clergymen, lawyers, doctors, teachers, painters, actors, and musicians are far more numerous, proportionately, than they were; and their pleasant lives are all due to machinery.

Indeed, were it not for machinery many of the inhabitants of this kingdom would not exist. The population of England at the Norman Conquest was about 2,000,000; in 500 years it had scarcely doubled. The conditions of life when muscle was the sole motive power, were too hard for all but the exceptionally strong. Professor J. W. Draper has given us a picture of existence in the middle ages. "The houses were of wood, daubed with clay, and thatched with straw and reeds. They had no windows, and, until the invention of the saw-mill, very few had wooden floors. The luxury of a carpet was unknown; some straw scattered in the room supplied its place. There were no chimneys; the smoke of the ill-fed, cheerless fire escaped through a hole in the roof. . . . . The bed was usually a bag of straw, a wooden log served as the pillow." Æneas Sylvius, who afterwards became Pope Pius II, has left an account of a journey he made to the British Isles in 1430. He describes the houses of the peasantry as constructed of stones put together without mortar; the roofs were of turf, a stiffened bull's hide served for the door. The food consisted of coarse vegetable products. In some

places they were unacquainted with bread. Crucified labor had not then even the poor consolation of having machinery and capital to share its woes.

The outcry against machinery is, when investigated, found to be directed against its increase, rather than its existence. A proposal for its abolition would raise a torrent of protest. For instance, the veriest Tower Hill demonstrator would be aghast at the railways being put out of use; he knows that it would mean immediate starvation. The fitter does not desire to do the old hard work of hammer and chisel, now better executed by the planing machine. The shipbuilder would be indignant if the ironworker proposed to destroy the converter and the Siemens-Martin furnace, and to return to puddling, because he knows that increased price of plates would mean lessened demand for shipping. Probably every one would be satisfied if the additions of the last four or five years could be done away with. We all like to gather fruit, but we object to the labor of planting trees for posterity. It is the constant change of conditions that presses so heavily on the present generation, and particularly on the working classes. They have to be ever adapting themselves to an altered environment, and the process is very trying to the least apt of them. Unfortunately, this seems to be a law of existence. Were the population absolutely stationary, things might be different. But it always increases, in this country at least, and the moment life becomes easy and pleasant the rate of growth augments to upset the arrangement. What the end will be no one can tell, but at least we know that all great improvements have come out of suffering. In the meantime the best we can do is to try and ease the tight places in the great social machine, and not to enter into rash experiments with undue haste. We see how much individual pain comes from the slow unfolding that occurs naturally, and we may be sure that even were there all the good in the radical schemes of socialists and collectivists that their authors believe, their sudden introduction would be attended with disaster and death to immense numbers. In spite of the misery and destitution that exist, it is impossible to deny that the conditions of living have improved in a marvelous manner during the last fifty years; that the nation is better fed and clothed, and has far more social and intellectual enjoyments. It may be that we have not followed the best or the wisest course, but it is certain that to retrace our steps would carry us to privations and sufferings of which we can form no adequate conception.— *Engineering.*

Word has been received from London, Eng., of the explosion of a boiler on the steamer *Tannadice* shortly after she had left Port Louis for Bombay. Four men were killed and several others were injured. The vessel was also seriously damaged, and she returned to Port Louis. The accident occurred about September 5th.

The bold Knight du Bois pranced up and down before the castle of Montgomery on his gaily caparisoned steed.

Presently a fair lady looked out over the portcullis towards him.

And she was very fair; so fair that the bold Knight du Bois stopped his prancing steed to look at her. She was not agitated by his gaze, but continued watching the knight.

He waved his sword at her, and still she was unmoved.

"By my halidom!" he shouted as he looked upon her.

She shook her head.

"No," she replied, "no, we don't want to buy anything to-day.

And, so saying, she disappeared.

[N. B.— Our scissors editor contributes this, but cannot remember where it came from. — Ed.]

The Locomotive.

HARTFORD, NOVEMBER 15, 1894.

J. M. ALLEN, *Editor.* A. D. RISTEEN, *Associate Editor.*

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AN explosion took place on October 25th on board the French cruiser *Arethuse*, at Brest, while her engines were being tested preparatory to sailing for the east in order to reinforce the French squadron in Chinese waters if such a step be necessary. Six men were killed and twenty others were badly scalded. The first report of the disaster magnified it considerably, and it was generally believed that one of the cruiser's boilers had burst. It is now believed, however, that the explosion was due to the bursting of a steam-pipe. The accident caused great excitement ashore and about the docks, and this was increased when it was discovered that fire had broken out aboard the cruiser. The situation on board finally became such that her commander brought her alongside one of the docks, and the flames had to be extinguished by the crew, reinforced by detachments of marines and sailors from the dockyard, before the wounded could be removed.

THE *Annual Report*, for 1894, of the Chief of the Bureau of Steam Engineering, has been duly received. Among other interesting information in the *Report*, we find the following: "The rapid destruction of copper piping in several vessels has already caused serious embarrassment, and the reason for this deterioration has not yet been determined to an absolute certainty. As it always happens to a copper pipe conveying or surrounded by salt water, and as the injection or delivery pipe to a pump, or the coil of a fresh water distiller, is the part attacked, and as the deterioration occurs only in steel ships fitted with dynamos, it is thought that the injury may be caused by electrolytic action; for the copper of which the pipes are made is known to be of the very best quality, absolutely free from foreign matter, and therefore not affected by the corrosive action of salt water. In fact, precisely similar pipes, made of the same material, last almost indefinitely in iron vessels like the *Alert* or *Ranger*, which have no dynamos. Steps are being taken to find out the true cause of this rapid destruction and the means by which it may be prevented."

IT has been seriously proposed to construct a railroad up the Jungfrau, a famous mountain in Switzerland, whose ascent is almost as difficult and dangerous as that of the Matterhorn. The Jungfrau is nearly 14,000 feet high, and its summit is well up in the region of perpetual snow and ice. It is proposed to carry the railroad up in the usual manner as far as practicable, and then to strike boldly into the mountain and complete the ascent by means of a spiral tunnel. When the summit of the mountain has been so

nearly approached that it is no longer possible to give the ascending spiral of the tunnel a sufficient radius, the railroad will come to an end, and the journey will be completed by means of an elevator. It is proposed to blast off the summit of the mountain sufficiently to provide a suitable foundation for a hotel. If this project is carried out, it will certainly be the most striking example of railroad engineering that the world has yet seen. There are tunnels galore, and some few of them form spirals of a single turn or so; but, so far as we know, there is no example of such a gigantic corkscrew as the Jungfrau will require.

The Pitting of Boilers.

In an article recently published, M. Olroy, a French engineer, gives the result of his investigation into the pitting of boilers. Pitting is particularly likely to occur if a water very free from lime is used in a clean boiler. The pits take the form of conical, or, more frequently, spherical depressions, which are filled with a yellowish-brown deposit, consisting mainly of iron oxide. The volume of the powder is greater than that of the metal oxidized, so that a blister is formed above the pit, which has a skin as thin as an egg-shell. This skin contains, usually, both iron oxide and lime salts, and differs greatly in toughness. In many cases it is so friable that it breaks with the least shock, falling to powder, while in other cases the blister detaches itself from the plate as a whole. An analysis of the powder in the pits showed it to consist of 86.26 per cent. of peroxide of iron, 6.29 per cent. of grease and other organic matter, and 4.25 per cent. of lime salts, the remainder being water, silica, aluminium, etc. The skin over the pits was found to contain 38 parts of calcium carbonate, 12.8 parts of calcium sulphate, and 32.2 parts of iron oxide, with about 8 per cent. each of magnesium carbonate and insoluble matter. Feed heaters often suffer badly from pitting, particularly near the cold water inlet, and in boilers the parts most likely to be attacked are those where the circulation is bad, especially if such portions are also near the feed inlet. In locomotives the bottom of the barrel is most frequently attacked, and the largest ring. The steam spaces are generally free from pitting unless the boiler is frequently kept standing with water in it. As the water evaporates, pitting is then likely to occur along the region of the water line, a part which, in a working boiler, is generally free from attack. This is especially the case if longitudinal joints of the boiler are liable to be exposed by the evaporation of the water, and to form a ledge on which moisture can rest. When a boiler forms one of a battery, and is kept standing for a long interval, the top of the boiler is liable to pitting. Steam finds its way into it, and condenses on the roof, causing bad pitting there. Perfectly pure water containing no air does no harm, and steam alone will not cause pitting unless it gets a supply of air. The Loch Katrine water of Glasgow, which causes pitting on clean boilers, contains much gas. MM. Scheurer-Kestner and Meunier-Dolfus inclosed a polished iron bar in a natural water containing much oxygen, and no lime salts. The bar gradually rusted, but the corrosion ceased when the oxygen was used up. The bar was then removed, repolished, and put back, after which it remained perfectly bright. Repeating the experiment with water containing lime, the rusting was much less complete, the lime salts forming a protective layer on the iron, but on polishing this off corrosion recommenced. In distilled water the bar remained quite bright. The corrosion is much more rapid if the water contains carbonic acid gas as well as oxygen. In this case a voltaic action takes place. The rust first formed is electro-positive to the iron, which then dissolves away, decomposing the

water. It is for this reason, that in cases of pitting it is essential that all traces of the iron peroxide should be cleaned from the metal, or the rusting will continue.

— *Engineering.*

WHEN Conductor Bray of the south-bound train to New York made his rounds after leaving Hartford yesterday, he scrutinized very carefully and perhaps more than half doubtingly, a ticket offered him by Vice-President Allen of the Hartford Steam Boiler Inspection and Insurance Company. It bore the stamp of J. Scrugham Quin, October 1, 1875, and was sold by him to a prominent business man of this city, lately deceased. For some reason he did not use it, and it was found among his papers after his death. It was redeemed by the railroad company, who sold it to Mr. Allen. It bore the number 2,702, and was apparently as crisp and bright as on the day of its first issue. — *Hartford Courant.*

The Ventilation of the House of Representatives.

In a recent issue of THE LOCOMOTIVE we quoted, from a daily paper, certain figures relative to the ventilation of the National House of Representatives. Through the courtesy of Mr. Henry Adams we have since been provided with a copy of the reports on this subject that were submitted to the House Committee by himself and by Dr. J. J. Kinyoun. These reports contain a considerable amount of interesting matter.

"The air used for ventilating the basement and upper floors of the south wing of the U. S. Capitol, and also a part of the terrace rooms belonging to this wing, is taken from the Capitol grounds west of the building. The intake for the air consists of a tower, open at the top, and about 21 feet high, above the surrounding grounds. It stands about 390 feet in a west-southwesterly direction from the northwest corner of the south wing of the Capitol, and its surroundings are such that the condition of the air drawn in through it is quite satisfactory — as perfect, in fact, as could be desired, or be had anywhere about the Capitol." Doubtless many of our readers will remember this tower, which is apparently intended purely as an ornament to the grounds.

It appears from Mr. Adams' report, that the air used in ventilating the House is handled by one 16-foot fan, driven by a direct connected steam engine, and running ordinarily at a speed of about 55 revolutions a minute. This corresponds to a delivery of about 2,400,000 cubic feet per hour. The air supplied to the floor of the House enters through gratings, which "form easy, accessible places to be used as cuspidors, and as convenient openings through which pieces of paper, cigar stumps, remnants of fruit, lint from carpets, etc., are thrown or swept."

Dr. Kinyoun adds, "What is said of the gratings can also be applied to the carpet, which is not in the best condition. In some places it is saturated with tobacco expectoration, a condition which tends to make it none the less odorous. The same condition exists in the galleries, although to a lesser degree than on the floor of the Hall, except in the gallery opposite the Speaker's desk, where it is worse, odors of tobacco and other things being always prominent. When the galleries are filled, the main gallery particularly, the odors above referred to are augmented by others emanating from those persons who are never in the state next to godliness — the vagabonds who congregate in this gallery during the winter months for the sole purpose of keeping warm." The doctor also says that "the dirt that accumulates on the floor is of a complex nature, both as to the materials that compose it and the odors that it evolves. The sweepings

collected from time to time have shown on examination a little of everything — dirt from the street, dust, tobacco, food, fruits, nuts, paper, expectoration, and bacteria. This filth is subject to the air current, which acts as a distilling process, setting free the complex odors, holding the matters in suspension, and carrying them up into the Hall."

How would it do to turn the hose on our august legislators?

Peruvian Trepanning.

A recent article under this heading appeared in the *Scientific American Supplement*, and we confess that since reading it we have conceived a particular respect for Aztec surgery. Trepanning, or "trephining," consists in the removal of a button of bone from the skull for the purpose of removing some obstruction that interferes with the normal activity of the brain, or for gaining access to the cranial cavity for some other purpose. The operation is an old one in Europe, but until reading the article referred to, we were not aware that it had been extensively and successfully practiced by the Peruvians before the advent of the Spaniards. "The ancient Peruvians," says Mr. Hovey, "seem to have been adepts in surgery, as in everything else. They excelled in agriculture, mining, milling, weaving, and engineering. Their cyclopean ruins are marvels of architectural skill. Indeed, in many respects they surpassed their Spanish conquerors. Hence we are not surprised to be told that they included a knowledge of the art of trepanning among their accomplishments. Several single specimens of trepanned skulls have been sent from time to time to American and European museums; but the Muniz collection, exhibited at the World's Congress of Anthropology, and now in the custody of the Bureau of American Ethnology, is the most remarkable of its kind. The entire collection includes about one thousand skulls exhumed from the vicinity of Cuzco, Huarochiri, Tarma, Pachacamac, and Canete. They belong to Senor Manuel Antonio Muniz, M.D., Surgeon-general of the Peruvian army, and will shortly be returned to the Peruvian museum at Lima. Nineteen of these skulls are especially interesting as showing the methods and results of primitive trepanning." Mr. Hovey presents eight excellent photo engravings of trepanned skulls, and says that "what first strikes our attention is the fact that no signs are seen of the use of metallic instruments, which agrees with the theory that this trepanning was pre-historic. In some instances the cranial incisions were narrow, long, and straight, usually at right angles with one another. The cutting was what might have been done by an arrow point held vertically and drawn backward and forward, making a groove deeper in the middle than at the extremities. In other cases the direction of the cutting was constantly changed, so as to saw out an elliptical piece from the skull, the rough tool-marks being afterwards scraped smooth. In still other cases there appears to have been no cutting nor sawing, the entire process having been effected by scraping, and the opening thus made being circular. Occasionally the operation may have been post mortem, as in one skull where twenty distinct incisions are to be counted. If ante-mortem, the individual certainly could not have survived such heroic treatment. The supposition is, that in these cases the purpose was not surgical, but was merely to obtain a bone button to be worn as a trophy or a charm. Most of the nineteen trepanned skulls, however, show signs of a surgical or thaumaturgic purpose. There are indications of a subsequent sloughing of the bone, or else of reparative growth, either of which would prove the operation to have been ante-mortem. One skull was trepanned three times, the subject surviving two operations, but succumbing

to the third, which cut through two of the sutures. In several cases the partial or complete absorption of the plates and spongy substance between them is an evidence of the survival of the patient. In one skull the bone was plainly diseased, and suggests the possibility that the orifices were caused by decay, instead of artificially. In others the signs of previous cranial fracture are evident. In the head of a mummy the skull had been fractured by a blow, after which the scalp had been laid open and trepanning begun by three incisions, with the object of removing the broken part, but discontinued on account of the death of the patient."

In one case illustrated by Mr. Hovey, the skull was small and thin, and was undoubtedly that of a young woman. Some distance from the trepanning there is a depression in the skull, which was probably produced by a blow received a considerable time before the operation. It is thought likely that this depression may have induced the diseased condition for the cure of which the trepanning was performed. At all events it is certain that operations to relieve the patient were performed successively until the perforations merged into one very large opening, four inches long by more than one inch wide. "This enormous aperture was covered by a silver plate found in the mummy case with the remains. The marks of its seat in the skull are distinctly visible, but the plate itself has not been sent to this country, being still in the possession of Dr. Muniz, who vouches for the facts. There is every indication that the patient long survived the series of operations performed, making this ancient Peruvian case worthy of being mentioned along with the historical record of the Count of Nassau's being trepanned twenty-seven times during King William's wars.

"The results of modern trephining, with the improved instruments, are generally anything but encouraging. Promptness is demanded in beginning, and great caution in proceeding; hence, the opinion prevails that greater success attends private practice than those cases where there is delay in getting the patient to the hospital, and a subsequent expedition arising from the multiplied claims on the surgeon's attention. According to Gross, trephining is nearly always fatal in the hospitals of Paris and Vienna. The proportion of recoveries in the hospitals of London, Dublin, Edinburgh, and other large cities of Great Britain is officially reported as only one in four cases. A similar report is made by the New York hospitals, where it is said that eleven in forty-five recover. This makes it remarkable, that in the Muniz collection, eight out of the nineteen individuals whose skulls were trepanned evidently survived one or more operations. Taken as a whole this unique collection is regarded by the Bureau of Ethnology as 'by far the largest and most instructive assemblage of specimens of primitive trepanning thus far brought together, and as of special note in that it demonstrates certain points that have been heretofore obscure.' It is not denied that the operations may have been partly thaumaturgic — *i. e.*, for the expulsion of evil spirits — but the indications are that there was also a degree of intelligent surgery adapted to remedy cranial fractures, and also to relieve certain diseases of the brain."

"A Remedy for Education."

Under this startling title, a writer in the *New Science Review* presents many thoughts and suggestions that should be useful to those who wish to improve our present educational system. "There are two great things that education should do for the individual," he says; "it should train his senses, and teach him to think. Education, as we know it to-day, does not truly do either; it gives the individual only a vast accumulation of facts, unclassified, undigested, and seen in no true relations. Like seeds kept

in a box, they may be retained, but they do not grow. For years the mind is filled with facts that the mind is not trained to digest. To the physical body food is of value only when it is digested. So it is in the mind, with mental food; but if digestion were made continuous, perfect, and ever equal to the supply of food, overfeeding in either mind or body would be impossible. But in the education of to-day the digestion is not equal to the feeding.

"The greatest educational need of the individual is a trained mind — a mind that is ready on the instant — not the next day. With most persons the intellectual brilliancy, the proper thing to say, comes as an after-thought. An after-thought is but a beautiful possibility designed to fit a lost opportunity. It is no more helpful to a man than a flattering epitaph on his tombstone. With most persons this wit is like a night telegram,— it is not delivered until the next morning. Man expects his hand to be instantly ready to perform any motion of which it is capable; but he is resigned if his mind does not act quickly. He says that readiness is born with people; it cannot be acquired. If a man's heart, lungs, or stomach are weak, he consults specialists, and never gives up until he obtains relief. But if he cannot remember names or faces; if he is subject to that intellectual remorse known as after-thought; if he has no eye for color, or taste for music; if he has no command of language; if there is lack of power in any respect in his mind, he is perfectly resigned, and says, 'I am as God made me, and so I must remain.' When man fails he always does this. He says, 'I am as God made me;' but when he succeeds, he proudly proclaims himself a 'self-made man.' It is not necessary to submit to any mental weakness. Training will do even more for the mind than for the body."

Mr. Jordan's entire article is well worth perusal, and we regret that we cannot quote it in full. His method for the study of English, for example, is superior to anything that we have seen in the schools and colleges. "Constant training in *words*," he says, "is a vital part of mental training. Words are but symbols for mental images. . . . . There can be no clear expression if there is not clear thinking. One great failure in our education is that there is too much memorizing of mere words, instead of memorizing of mental images or pictures that these words call forth. Words should be looked upon as living things; to be studied in themselves, in all their forms and phases, rather than merely studied about. We should have laboratory work in words. Mere study of synonyms from books will do but little real good; the words must be studied in life. I have found classes intensely interested and quickened for an hour or more in the study of a few lines of newspaper writing; perhaps but a criticism of some famous man of the day. It was studied word for word. If any word was adjudged strong or fitting, the reason why it was fitting in that situation was discovered; if it was weak, it what respect it was weak. If it meant more or less than the thought required; if it suggested an association or an element not in harmony, another word was substituted. In this was something higher than mere dogmatic, individual criticism; for be the word good or bad the choice must be justified. The critical and the imaginative faculties of mind were trained together; for every substitution of a new word was an appeal to the imagination sustained by the judgment. Thus, the ear became wondrously quick to perceive the force of a word, its music, its fitness. Words of color were studied; words of size, and number, and form; words expressing the extremes of ideas; words expressing differing degrees of intensity of the same quality; the power of short words; onomatopes; words of every class, looked at from every point of view. . . . We have many teachers in our schools, and professors in our colleges, who value words, and seek to teach in this spirit, so far as the rigidity of the system will permit; but this is not enough. This study of words is so vital an element in the training of the mind that it should be begun in the very earliest classes, and never be lost sight of in the whole school and college training of the individual. Compositions are written by the pupils, and returned to them with a few red ink interlineations and corrections of mis-spelled words, mispunctuation, wrong capitalization, or errors in syntax, and but the occasional substitution of a better word. One hour's study of words before a class, from any one of these compositions, would be worth more than a whole term of the usual work."

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The Locomotive.

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The Shamokin Explosion.

Our readers are doubtless familiar with the general facts of the tremendous boiler explosion that took place in the outskirts of the town of Shamokin, Pa., on October 11th. No explosion approaching this one in magnitude has occurred in this country, and

SITE OF THE SHAMOKIN EXPLOSION.

hence it attracted wide attention, and was described rather fully (though somewhat inaccurately) in the daily papers. The loss of life at Shamokin was comparatively small. Many a less notable explosion has had a larger death list, but so far as the number of boilers involved is concerned, the present disaster is without a parallel. The great boiler explosion at Friedenshütte, in Upper Silesia, on July 25, 1887, approaches

it more nearly than any other, in this respect.* In the Friedenshütte explosion twenty-two boilers (four of which were empty) burst simultaneously. Three firemen were killed instantly, and nine other men were injured so badly that they died three days later. In addition to these, thirty men and women were more or less severely injured.

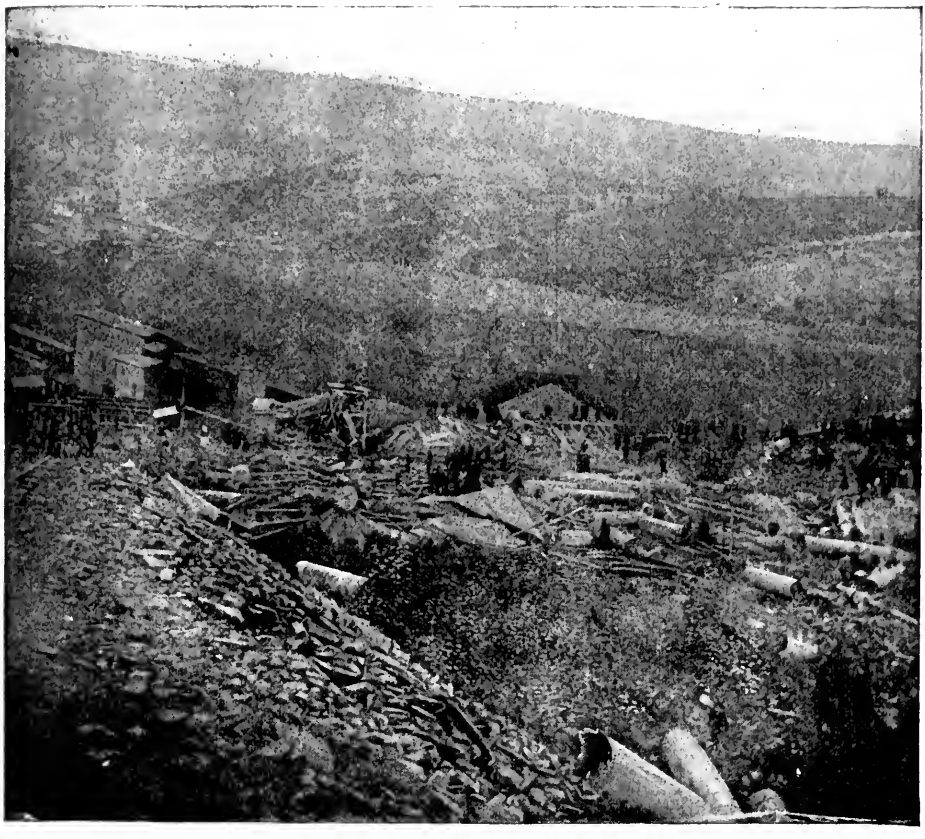
With regard to the explosion at Shamokin we may say, that the destruction was so general and so complete that it is difficult to find a satisfactory explanation of it. If the boilers had been insured, we should have had an accurate knowledge of them which would, undoubtedly, have been of great service ; but in the absence of such definite knowledge, we cannot say positively what the cause of the disaster was. One of our most experienced men visited the scene of the explosion shortly after it occurred, and we present the following extracts from his report:

"When I reached the site of the Henry Clay colliery the ground was pretty well cleared up, but I managed to see a good many broken sections of the boilers, most of them partly buried in the culm banks with the fractured ends projecting upwards, and also many broken steam and water pipes, steam and water valves, fire fronts, and beams for supporting the boilers. I also made numerous enquiries from employes who were present both before and after the accident ; but their statements were so conflicting that I am in doubt as to the correctness of any of them. However, I will give you the facts as I have obtained them. There were thirty-six plain cylindrical boilers, each 34″ in diameter and about 44 feet long outside of the heads, the heads themselves being of cast-iron, flat or nearly so, and about two inches thick. The sheets were single riveted, and varied in thickness from .26″ to $\frac{5}{16}$″. I was informed that there were six batteries, with six boilers in each. The individual batteries were further separated by longitudinal division walls whose thickness I could not ascertain, into groups of three boilers each, in such a manner that in every case three boilers were set over one fire, and connected at the front and rear and top and bottom of the heads by cast-iron water and steam pipes 3″ in diameter. Each sub-battery of three was also provided with a cast steam pipe, 12″ in diameter and about 8 feet long, with 3½″ flanged outlets that connected with 6″ cast-iron nozzles riveted to the center sheets of the respective boilers, and also with two 4″ flanged outlets, on top, for safety-valves. There were two 3½″ safety-valves to each sub-battery, or four such valves to each battery of six boilers. In addition to these openings in the steam pipes that I have described, there was, in each one, a 4″ outlet on the front side, and to this was connected a 4″ pipe about 5 feet long, at the end of which was a 4″ tee shaped stop-valve. The stop-valves were connected to a 12″ cast-iron pipe, built up of eight-foot lengths, and extending across the entire battery of 36 boilers. At the center of this main pipe there was a 12″ cast-iron tee, to which was connected a 10″ wrought-iron pipe, which led down to the breaker, and from which the pumps were also supplied.

"On the top of each boiler were riveted cast-iron flanged hangers with cored openings for hanger bolts and cotters; and two heavy cast-iron beams with cored bolt holes extended across each nest of three boilers, some 10½ or 11 feet from either end, the boilers being suspended from them by hangers. The feed and blow connections were attached, in every case, to the bottom of the shell, at the rear end. I saw some feed-valves, but no checks; and I am not sure that there were any checks. Pumps were used to supply the boilers, and there were also heaters, though I did not find out what kind of heaters they had. Ninety to ninety-five pounds of steam were usually carried, and sometimes the pressure was up to 120 pounds. [Assuming the iron plates of the

* The Friedenshütte explosion is described and illustrated in THE LOCOMOTIVE for June, 1888.

shell to have a strength of 50,000 pounds per square inch, and taking the efficiency of the longitudinal, single-riveted joints at 50 per cent., which is probably about the right figure, it is easily seen that at 120 pounds pressure the factor of safety of the shell was only about *three*.—Ed.] The explosion occurred about 7.30 A. M. on the morning of October 11th, shortly after the day shift of firemen came on. In this shift there were four men in addition to the water tender. All five were killed instantly, and another person — a boy who was at work near the culm tipple in front of the right-hand boiler — was badly scalded and injured about the hips, so that he died a day or two afterwards.



General View of the Ruins.

Several others were injured, two of them rather seriously; they are now in the hospital, and are expected to recover.

"In looking over the remaining parts of the boilers I saw there, I noticed that most of them broke through the line of rivet holes of the small courses in front of the steam outlets, nearly in two halves. Others broke on the small courses back of the front hangers. I saw one piece with the front course and front head, and another with five courses and a front head. I also noticed a part of two courses torn in shreds and badly battered up, but I am not sure whether this was a piece of a boiler or of one of the iron stacks, as it was covered with mud and blackened with coal dust.

"In the course of a talk I had with one of the firemen, he informed me that he

had been on the night shift, that he had been home only a short time when he heard the noise, and that it seemed to him 'like a pack of fire-crackers going off, only not so loud, more like squibs.' He said 18 boilers on the right and nine on the extreme left, had blown up, leaving intact a battery of six, which were on the left-hand side of the center, while three other boilers adjoining this battery were thrown down out of their beds. I am not sure that this was correct, as others told me that all nine were thrown down and scattered about, except that three of them fell together. It is possible that the latter version is the correct one, as the photograph that was taken on the day after the explosion shows three boilers lying together, side by side. The sections that were thrown backward landed on the hill in the rear of the original position of the boilers, and did no further damage. One piece was carried over a culm bank fully 100 feet high, and in its passage over the top of the bank it scooped out the culm to a depth of about one-third of its own diameter, landing in a valley on the other side. Another piece containing five courses was thrown across the valley to the northwest, and landed on the slush bank west of the breaker after a flight of about 500 yards. Another piece went through the upper corner of the breaker, about 500 feet away, slightly injuring a boy who was working there. Still another fragment went through a hoisting-engine house about 300 feet distant, cutting the cable and carrying out the side of a small house fifty feet below. I saw another piece about thirty feet long, with one head still in it, entirely buried under an ash bank except for about two feet of its length that was still uncovered. I was informed that this was a part of one of the exploded boilers, but I doubt it on account of its position, although the condition of the broken end is very similar to that of a number of other pieces.

"I have made some inquiries regarding the cause of this explosion, but thus far I have been unable to find anyone who is willing to express an opinion. It seems to me, however, that the iron in these boilers may have been greatly weakened by the vibrations and strains due to repeated expansion and contraction; for most of the breaks seem to have occurred at points most likely to be affected by such a cause. The iron in all these boilers is of very poor quality, but it is of about the same grade as is used in very many other boilers in the coal regions."

Inspectors' Report.

OCTOBER, 1894.

During this month our inspectors made 8,509 inspection trips, visited 18,024 boilers, inspected 6,556 both internally and externally, and subjected 747 to hydrostatic pressure. The whole number of defects reported reached 12,323, of which 910 were considered dangerous; 47 boilers were regarded unsafe for further use. Our usual summary is given below:

Nature of Defects.	Whole Number.	Dangerous.
Cases of deposit of sediment,	905	29
Cases of incrustation and scale,	1,930	71
Cases of internal grooving,	115	8
Cases of internal corrosion,	643	57
Cases of external corrosion,	832	54
Broken and loose braces and stays,	182	27
Settings defective,	333	34
Furnaces out of shape,	558	23

Nature of Defects	Whole Number.	Dangerous.
Fractured plates,	326	38
Burned plates,	246	18
Blistered plates,	260	9
Cases of defective riveting,	1,545	31
Defective heads,	116	12
Serious leakage around tube ends,	2,375	240
Serious leakage at seams,	577	43
Defective water gauges,	436	76
Defective blow-offs,	168	52
Cases of deficiency of water,	17	6
Safety-valves overloaded,	51	18
Safety-valves defective in construction,	102	36
Pressure-gauges defective,	527	21
Boilers without pressure-gauges,	6	6
Unclassified defects,	73	1
Total,	12,323	910

Boiler Explosions.

OCTOBER, 1894.

(231.)—A boiler exploded, on September 29th, at Hodge's mill, near Puxico, Mo., killing two men named Johnson, one unknown man, and two boys named Lee and Dixon. [We received notice of this explosion too late to insert the account in its proper place in the September list.—ED.]

(232.)—On October 1st a boiler exploded in F. B. Woodbury's chair factory, in the town of Orwell, near Pulaski, N. Y. The boiler was blown through the building, crushing floors, walls, and machinery for a distance of 50 feet, and breaking a hole some 20 feet in diameter in the outer wall. Fred Hilton had one arm crushed between the wrist and elbow, making amputation necessary. Lewis Finster, Edward Stevens, and William Sparks were badly scalded and bruised, and Engineer Sheppard was slightly hurt.

(233.)—A boiler exploded, on October 2d, at Boyer & Caldwell's oil well, near Cooperstown, Pa. The boiler-house was torn to fragments, and boards and pieces of timber were scattered all about. Lemuel Hutchman, who was unloading tubing from a wagon near by, was blown fifty feet and probably fatally injured. Three of his ribs were broken and he was otherwise seriously injured. The boiler alighted in a field, three hundred yards from its original position.

(234.)—A boiler explosion occurred on October 3d at the Merchant's Cold Storage Company's plant, in San Francisco, Cal. The nipple under the rear of the boiler, where the feed and blow-off pipe were connected, gave way while the boiler was in use and under 95-pounds pressure. Peter Olsen, the engineer, was near the boiler at the time, and was scalded from head to foot. His throat and lungs were also fearfully burned, and he died after about three hours of intense suffering.

(235.)—The boiler furnishing motive power for the pile driver used in constructing the Louisville and Jeffersonville bridge, Louisville, Ky., exploded on October 4th.

Engineer W. G. Fitzhugh and a machinist named Samuel Fahringer were badly scalded. Five other men who were standing near by were also slightly burned.

(236.)—A boiler exploded, on October 4th, in Shultz's saw-mill, at Tygart Fork, near Parkersburg, W. Va. Frank Haley was instantly killed, George Shultz was scalded, bruised, and cut, about the face and head, so that he died shortly afterwards. Samuel Cook and Edward Sams were also scalded and burned so severely that they died within a day or two. Henry Mayhew was painfully injured, but will recover, and D. R. Sams was slightly bruised. The largest fragment of the exploded boiler was blown over the heads of about thirty school children, who were sitting on the log-carriage. It struck the ground some 250 feet away. The engine was also broken to pieces, and was found in the woods, 200 feet from its original position.

(237.)—On October 4th, a locomotive fell through a trestle on a lumber company's tram road, near Charleston, Mo. The concussion caused the boiler to explode, and Engineer Daniel Young and his fireman were fatally injured.

(238.)—A boiler exploded, on October 5th, in the Union Iron and Steel Company's "Siberia" mill, at Youngstown, Ohio. John Davis, a puddler's helper, was badly burned about the face, neck, and arms.

(239.)—On October 6th, a large boiler exploded at Mizell & Bros.' mills, King's Ferry, Fla. Engineer Fred Williams, Fireman Thomas Grant, George Noble, and Boston Taylor were frightfully scalded, and Noble and Grant are expected to die. The property loss was estimated at $5,000.

(240.)—Mr. M. B. Devane's cotton-gin, near Cecil, Ga., was destroyed on October 6th, together with its machinery and other fixtures, by a boiler explosion. Mr. James G. Futch was decapitated by a fragment of the boiler. Another piece of the boiler struck Mr. Nathan Devane, fracturing several of his ribs and perhaps injuring him internally. Two other men, whose names we have not learned, were severely scalded, and one man had his foot broken by a falling timber.

(241.)—On October 9th, a boiler exploded in L. C. Downtain's cotton-gin, at Eastland, Texas. Engineer W. D. Skelton was killed, and O. C. Scarborough, George Parker, and H. Y. Hill were injured.

(242.)—A small boiler exploded, on October 11th, near the Standard Oil Works, in Los Angeles, Cal. The roof of the building in which the boiler stood was blown about 250 feet into the air, and the contents of the building were scattered promiscuously about. Nobody was hurt. The boiler was used for supplying steam to a pump.

(243.)—A fearful boiler explosion occurred, on October 11th, at the Henry Clay shaft, at Shamokin, Pa. Twenty-seven boilers out of a battery of thirty-six exploded. The boiler-house was utterly demolished, and Thomas Carr, William Boyle, William Estick, and William McLaughlin were killed. J. J. Didian and John Flickensteine were also fatally burned, and died in a short time. William Cuimm, Peter Heck, and Dennis Brennan were badly scalded, and the shaft was filled with débris. The colliery is operated by the Philadelphia & Reading Coal and Iron Company, and was considered to be one of the best-equipped plants in the Shamokin district. The property loss is estimated at $100,000. Sixteen hundred men and boys were thrown out of employment. A further account of the explosion will be found on the first page of the present issue.

(244.)—The boiler of locomotive No. 126, of the Delaware, Lackawanna & Western railroad, exploded on October 12th, at Glen Ridge, N. J. The big engine turned a somer-

sault in the air, landing upon the track with her cab-end forward and her wheels in the air. Elmer Cumming, the engineer, was pinned to the ground beneath the wreck of the locomotive, and was dead when released. The fireman, Charles Barcland, was fearfully injured, and died during the night.

(245.)—A boiler exploded, on October 12th, at Down's saw-mill, in Sims township, near Paris, Ill. The boiler was blown through the roof of the building in which it stood, and landed some distance away. Engineer John W. Young was badly scalded, but it is believed that he will recover.

(246.)—The boiler in Woodring's furniture factory, at Waverly, Iowa, exploded on October 12th, doing a considerable amount of damage. John Hinmon, the engineer, was badly scalded about the face, hands, and legs, but he will live. The boiler was a new one, having been in use only about a year.

(247.)—Word received from Sacramento, Cal., says that the crown-sheet of a locomotive blew out near Colfax, on October 15th. Engineer G. W. O'Neil had one leg broken, and Fireman Chinar was blown out of the cab and badly bruised.

(248.)—A boiler exploded on October 15th, at M. H. Keller's saw-mill, situated on Sugar Run, about fifteen miles from Bradford, Pa. George McAllister and Augustus Carlson were instantly killed, and William Dyer was injured so badly that he died a day or two later. George Lewis was also injured about the legs. The mill was entirely wrecked.

(249.)—A boiler in the Preetorius Lumber Company's mills, near New Madrid, Mo., exploded on October 15th. At the time of the explosion the only men present were James Holmes, the engineer, George Burton, the watchman, and Volney Burton, the watchman's brother. Volney Burton received a fracture of the skull, and died instantly. James Holmes was thrown over a pile of lumber, and was injured so badly that he lived only about a quarter of an hour. George Burton was scalded so fearfully that recovery is impossible. The boiler was torn into three parts, all of which landed more than 300 feet from the scene of the explosion. The property loss is estimated at $4,000.

(250.)—A heating boiler exploded in the basement of a tenement house in Grand Rapids, Mich., on October 16th, shattering the entire first floor of the building, and creating a panic on the upper floor, where William L. Sage and his family live. Mrs. Sage and her baby were thrown down, and the account says that both were "sadly blackened" by the dirt and soot that came up from the regions below. The family on the first floor had moved out a few days before, and it is probable that had that floor been occupied, somebody would have been killed. The day was pleasant and the boiler was running light; but "had the weather been cold and the steam up to cold weather pitch, the whole building would undoubtedly have been wrecked, and several lives lost."

(251.)—A hot-water boiler exploded, on October 16th, in the basement of Charles H. Strong's residence, Erie, Pa. The kitchen was almost completely wrecked, and considerable damage was done to the dining-room overhead. The explosion occurred shortly before four o'clock in the morning, and nobody was hurt; but the property loss is estimated at about $5,000.

(252.)—On October 17th a boiler exploded in Henry Waters' planing-mill, in Carey, Ohio. The north end of the mill was torn to atoms. Solomon Sterling, the engineer, was buried beneath the ruins, and when rescued it was found that one of his arms was broken, and that he was badly cut and bruised about the head and other parts of the

body. It is also said that he was seriously injured internally. John Greno's leg was crushed, and amputation was necessary. Thomas Hart was blown out of a second-story window, but he alighted in a pile of sawdust and escaped injury. One fragment of the boiler, weighing about 1,000 pounds, was projected nearly horizontally, and after describing an erratic orbit in the course of which it demolished several fences, it came to rest about 500 feet from its starting-point.

(253.)—The boiler of an illicit still exploded in a tenement house in New York city, on October 18th, severely scalding John Jobesky and Paulina Bossuk and her infant daughter Jessie. The woman's husband, Hermann, supposed to be the owner and operator of the still, ran away after the explosion, leaving his wife and child crying for help. A dozen barrels of mash were found in the room. Revenue officers took charge of the still, together with the finished and unfinished liquor on hand. The still was only a block from the Madison street police station.

(254.)—A boiler exploded, on October 20th, in Charles Hoerlein's carpet-cleaning establishment, on Cottage Grove avenue, Chicago, doing considerable damage, but fortunately injuring no one.

(255.)—On October 21st, a small boiler used for heating water in Simon Brustman's bakery, Chicago, Ill., exploded, fatally injuring the proprietor, and severely scalding his son, Harry Brustman, and a workman named Lawrence Walters. The damage to property was slight.

(256.)—Clift's saw-mill, twelve miles north of Princeton, Ky., was wrecked by a boiler explosion on October 23d. The workmen were about the mill at the time, but they all marvelously escaped injury. One man was firing up at the time, and the blade of his shovel was torn away, leaving the handle in his hands. A crowd of women and children had just left the place.

(257.)—On October 24th a boiler in the M. B. M. Peacock grain elevator, at Markesan, Wis., ruptured along a joint, and Adolph Schubert, an employe, was severely but not fatally scalded. The brick-work of the setting was all blown down.

(258.)—A boiler exploded, on October 24th, on the tow-boat *Sam'l Little*, while she was lying at the foot of Central wharf, Boston, Mass. The damage was slight, and we did not learn of any personal injuries.

(259.)—On October 25th a boiler exploded in the Atlantic City laundry, Atlantic City, N. J. Nobody was injured.

(260.)—A slight boiler explosion in the power-house of the electric car system at Leavenworth, Kan., on October 25th, stopped the cars and left the city in darkness.

(261.)—Two boilers exploded, on October 26th, in C. H. Thomas' saw-mill, at Woodland, near Bainbridge, Ga. Crawford Hawkins was killed instantly, and Lewis Strickland and George Strickland were fatally injured. Archie Baker and two other men named Wimberly were also seriously scalded and otherwise injured.

(262.)—A boiler in the wool works of J. M. Rogers, Paterson, N. J., exploded on October 29th, carrying away a part of the building. Several of the employes were slightly injured.

(263.)—On October 30th a boiler exploded in A. T. Kreps' mill, in South Parkersburg, W. Va. John Kreps and Daniel Jones were instantly killed, and Benjamin

Mounts was badly bruised. Kreps was a son of the owner of the mill, and was running the boiler in the absence of the regular fireman. This explosion seems to have been due to the fact that there was a stop-valve between the boiler and the steam-gauge and safety-valve. The Parkersburg *Journal* says, "The boiler being red hot and no water in, why, of course it exploded when water was turned into it." We don't know how that was, but the existence of the deathly stop-valve seems to be quite enough to explain the explosion, especially as the valve was closed when found among the débris.

(264.)—The boiler at T. D. Linder's ginnery, two miles from Hartwell, Ga., exploded on October 31st. James Wilson and Edward Evans were killed instantly, and the account adds the horrible detail that the "bodies of the two men were gathered up in baskets." The engineer, also named Wilson, was badly scalded and bruised, and his physicians say that he cannot live.

A NATURAL gas explosion occurred in the electric light station at Oil City, Pa., on October 14th. No serious damage resulted, and nobody was injured.

A STEAM radiator in the Hatch Cutlery Works, at South Milwaukee, Wis., exploded on October 4th, partially wrecking the nickel-plating room. There was no loss of life, but Mr. W. B. Collins was somewhat injured.

A VIOLENT explosion occurred in the bottling works of Seth Butler, at Des Moines, Iowa, on October 10th. The steam pipe connecting a radiator with the boiler burst, and bottles, desks, and other office furniture were thrown about the room. The loss amounted to about $300.

WILLIAM MILLER, John Holstrom, and A. B. Sparrow were killed, on October 8th, by the bursting of a steam pipe in the Illinois Steel Works, at South Chicago. Thomas Dorsey, Oscar Wagner, Joseph Todhunter, and Peter Moxey were badly injured, and it is doubtful if they can recover. About forty other workmen were burned more or less severely.

THE youngest son of John Drumheller, of Blanchester, Ohio, was experimenting in his back yard, on October 13th, after the manner of Watt. He had improvised a steam engine and was trying to run it by means of a boiler whose fundamental ingredient was a tin fruit-can. The boiler exploded, scattering steam and hot water in all directions, and the boy was seriously scalded from head to foot. An elder brother, who was watching the experiment, was also slightly burned about the face.

A CURIOSITY in railroad building is the road running from Ismid, a harbor about 60 miles from Constantinople, to Angora, about 300 miles. The bridges, ties, telegraph poles, and rails are iron, most of which are of German manufacture. The bridges average about four to the mile, there being 1,200 of them, the longest having a stretch of 590 feet. In addition to these, there are 16 tunnels, the longest measuring 1,430 feet. This is the only railroad which penetrates the interior of Asiatic Turkey, the Smyrna lines being near the coast.— *Railway Review*.

The Locomotive.

HARTFORD, DECEMBER 15, 1894.

J. M. ALLEN, *Editor.* A. D. RISTEEN, *Associate Editor.*

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Papers that borrow cuts from us will do us a favor if they will mark them plainly in returning, so that we may give proper credit on our books.

ANOTHER year is gone; and may the new year be a happy one to all! The index and title-page for THE LOCOMOTIVE for 1894 are in preparation, and will be sent to those who have preserved their copies for binding. Bound volumes for the year will also be ready in January, and may be had at the usual price of one dollar each.

IN the course of an article on mosquitoes, quoted from *Insect Life* in a recent issue of the *Scientific American*, Mr. Howard Evarts Weed tells how he succeeded in freeing a certain locality of these troublesome pests by adding kerosene to the tanks of water in which observation showed that the mosquito-larvæ were developing. He adds, "I have also found that kerosene is a good article to use to prevent mosquitoes from annoying one when they are numerous. A little of it is smeared on the back of the hands and also upon the face. At first thought this would seem to be a disagreeable operation, but a trial of it will prove that it is not so in the least. It is quite effective in keeping the mosquitoes away, and it is certainly much better than the Florida method, which, I have been told, is to remain secreted under a large iron kettle, and with a hammer to clinch the bills of the mosquitoes as they are thrust through the kettle."

"Inspection Cheap" means "Cheap Inspection."

An esteemed foreign correspondent writes to THE LOCOMOTIVE as follows: "I could tell you some very funny stories about boiler 'inspection' as carried out by some companies in this country, the result of utterly incompetent men being employed in consequence of the low rate due to competition. I remember once being called on to advise about some boilers, and while I was carrying out a hydraulic test of one of them the 'inspector' of the company under whose charge they were turned up and stopped the whole thing. The test revealed a number of serious defects and led to my at once shutting down the boiler and having certain plates cut out; but the 'inspector' went off and wrote a special report certifying that he had made a satisfactory *thorough* inspection! When the plates I had condemned were cut out we found that the seams for an aggregate length of *fourteen feet* were cracked between the rivet holes, nearly through the plate; the solid metal left being nowhere over one-sixteenth of an inch thick!"

Of course all men are fallible, and the most experienced and thoroughly honest inspector may occasionally fail to detect a defect; but it is evident that such lapses will be reduced to a minimum by employing the best men that can be had. Care in the selec-

tion of inspectors is the first duty that an insurance company owes to its patrons. It is not always an easy one to fulfil, however, for a man may have handled boilers intelligently all his life, and yet make an extraordinarily poor inspector.

Concerning Earthquakes.

Buckle, in his *History of Civilization in England*, touches upon the rôle that earthquakes have played in the development of civilization in countries commonly subject to these disturbances, and calls attention particularly to the fact that the terror inspired by seismic phenomena does not diminish with their continued repetition, but rather increases. In this connection the following passage from an old number of the *Popular Science Monthly* may be of interest:

"'I must not omit to mention those prognostics which were derived from animals. They were observed in every place where the shocks were such as to be generally perceptible. Some minutes before the shocks were felt, oxen and cows began to bellow, sheep and goats bleated, and, rushing in confusion one on the other, tried to break the wicker-work of the folds; dogs howled terribly, geese and fowls were alarmed and made much noise; horses that were fastened in their stalls were greatly agitated, leaped up, and tried to break the halters with which they were attached to the mangers; those that were proceeding on the roads suddenly stopped, and snorted in a very strange way. The cats were frightened, and tried to conceal themselves, or their hair bristled up wildly. Rabbits and moles were seen to leave their holes; birds rose, as if scared, from the places on which they had alighted; and fish left the bottom of the sea and approached the shores, where at some places great numbers of them were taken. Even ants and reptiles abandoned, in clear daylight, their subterranean holes in great disorder, many hours before the shocks were felt. Large flights of locusts were seen creeping through the streets of Naples toward the sea the night before the earthquake. Winged ants took refuge during the darkness in the rooms of the houses. Some dogs, a few minutes before the first shock took place, awoke their sleeping masters, by barking and pulling them, as if they wished to warn them of the impending danger, and several persons were thus enabled to save themselves.' What it is, before the sound or shock of earthquake is felt, which warns both animals and human beings of the approach of some dreadful catastrophe threatening the very basis of their existence, no one, of course, can say."

The Early History of Crucible Steel.

It was in the immediate neighborhood of Sheffield, England, that the first successful process for the fusion of steel on a commercial scale was devised. The late Dr. Percy, a leading authority in general metallurgy, said: "Formerly, so far as I am aware, steel was never melted and cast after its production, and in only one instance (namely, in the case of Wootz steel) was it ever molten during its production. Indeed, by the founding and casting of steel after its production its heterogeneousness is remedied, and ingots of the metal can be produced of perfectly uniform composition throughout, and for the practical solution of this important problem we are indebted to Benjamin Huntsman of Sheffield."

As a recent journal appropriately remarked, "Huntsman's patient efforts, at last rewarded with success, entitle him to an elevated niche among the heroes of industry.

The invention of cast-steel was second in importance to no previous event in the world's history, unless it may have been the invention of printing."

Huntsman was born in 1704, his parents being natives of Holland, who came over and settled in England. He belonged to that sturdy religious persuasion, the Quaker body, which has done much for Great Britain, as it has for a large State in America, interested in the iron and steel manufacture. His character is shown by the fact that he would not allow any portrait to be taken of himself, and he refused an offer to be made a member of the Royal Society in 1750, when his fame had already begun to spread. . . .

In the early part of Huntsman's life, about 1740, there was one great drawback in connection with the development of Sheffield. All the materials used had to be imported from either Sweden or Germany. Blister or cement-steel was imported from those countries, or, in some cases, the material obtained was a raw puddled or natural steel. A considerable trade was also done with Newcastle-on-Tyne, where several combination furnaces were worked, probably because the Swedish bar-iron found its way there more readily, owing to the shipping facilities. Whether these latter furnaces existed when Huntsman first commenced his experiments is not very clear; but in 1774, M. Jars, a French expert who visited England in that year, remarked in his interesting *Voyages Metallurgiques*, "There are many manufacturers of iron and steel (cemented) at Newcastle-on-Tyne;" and it appears that a considerable quantity went to Sheffield. Huntsman, being a maker of watches and clocks, often experienced much inconvenience from the irregular quality of the imported blister-steel. For fine work of this class the utmost attention is essential to insure uniformity of production. He was then settled in Doncaster, and from reported proofs of his ingenuity it appears that he was already known as the "wise man" of the neighborhood. It is not surprising, therefore, to find that his active brain set to work to master the problem from the solution of which we are to-day reaping so great a benefit — the problem, namely, of producing cast-steel by fusion.

From a recent excellent paper by Mr. L. H. Holland, F.G.S., assistant superintendent of the geological survey of India, it would appear that Indian Wootz steel, usually found in conical ingots and made by the carburization of wrought-iron crucibles (so he states), has very likely been made in India for many centuries, especially in Trichinopoly. Nevertheless, Huntsman was very clearly the first to establish a fusion process on something like scientific lines, and to make it a practical and commercial success. Smiles, in his *Industrial Biography*, gives an interesting account of the discoverer, giving him full credit after very careful investigations. Moreover, M. Le Play, professor of metallurgy in the School of Mines at Paris, after carefully weighing all the evidence obtainable, stated that without doubt the credit of the invention belongs to Huntsman. Finally, a controversy was conducted in the London *Times*, some twenty-five years ago, and the discoverer, as we believe, was again fully vindicated.

Difficult as the problem must have been in the crude state of metallurgical knowledge at the time, Huntsman, having set his hand to the plow, would not turn back. The chief difficulty lay in obtaining a fire-clay that would enable him to make a vessel or crucible in which the bar-iron or cement-steel could be melted. At that time there was practically no knowledge as to the requisite chemical constituents of a fire-resisting material. There was uncertainty as to the character of the materials to be used in melting; melting appliances were imperfect; and there was difficulty in obtaining the most suitable fuels. These and other obstacles would have discouraged any but the stoutest heart. Mr. Frank Huntsman has informed me that evidences about the works were formerly abundant (and even quite recently some have been discovered) of the large

number of experiments that had evidently been tried in the early stages of the process. Buried salamanders are not unknown in the present history of metallurgy, and those found in the works of Huntsman afford a proof that in the past, as at the present time, success usually came after many trials.

Huntsman's first experiments were made at Doncaster, a town eighteen miles from Sheffield, to which city he removed about the year 1740. Here his further experimental work was carried out at Handsworth, a suburb of the town. Finally he removed to Attercliffe, a manufacturing district forming a part of the city, and his works are still in existence, considerably altered and enlarged, but situated in the street known to this day as "Huntsman's Row." Within a few yards of the works is Benjamin Huntsman's house, where he lived until his death at the age of seventy-two, on June 21, 1776. His remains lie in the family vault in Attercliffe cemetery.

The following excellent account of the methods originally practiced in Sheffield about 1764 is given by M. Gabriel Jars, in his *Voyages Metallurgiques*, edited by his brother and published in 1774: "Blister-steel is rendered more perfect by the following operation: Ordinarily, scrap and cuttings from articles of steel are used. Furnaces of fire-clay are used, of similar design to those for brass castings. They are much smaller, however, and receive the air by an underground passage. At the mouth, which is square and at the surface of the ground, there is a hole through the wall, from which the chimney stack ascends. These furnaces contain only one large crucible, 9 to 10 inches high and 6 to 7 inches in diameter. The steel is put into the crucible with a flux, the composition of which is kept secret, and the crucible is placed upon a round brick, set upon the fire-bars. Coal, which has been reduced to coke, is placed around the crucible and the furnace is filled. Fire is then put to it, and at the same time the upper opening of the furnace is entirely closed with a brick door surrounded by a circle of iron. The flame goes through the pipe into the chimney. The crucible is five hours in the furnace before the steel is perfectly melted. Several operations follow. Square or octagonal molds, made of two pieces of cast-iron, are put the one against the other, and the steel is poured in at one extremity. I have seen ingots of this cast-steel which resemble pig-iron. This steel is worked under the hammer, as is done with blister-steel, but is heated less highly and with more precaution, because of its liability to break. The object of this operation is to make the steel so homogeneous that there may be no flaw, as perceived in that which comes from Germany, and this, it is said, can only be done by fusion. This steel is not extensively used; it is employed only where a fine polish is required. Of it are made the best razors, some knives, the finest steel chains, some watch springs, and small watchmakers' files."

That Sheffield can pre-eminently claim the title of "Steelopolis," not less from its modern development than from its long-standing and traditional associations with the early developments of the metallurgical industry of iron and steel, is shown in an interesting manner by a Sheffield directory published by Yale and Martin in 1787, about ten years after Huntsman's death. We find that there were then some half-dozen manufacturers of adzes and hammers; about 50 makers of edge tools; not less than 40 engaged in file making; over 300 in pen-knife, pocket-knife, and table-knife manufacture; at least 50 in razor making; close upon 100 in scissors; and some 60 or 70 in the manufacture of scythes, sickles, and shears. Many of these, no doubt, were small workers, rather than large concerns; but it will be seen that here was the center for a considerable employment of steel. It was this, no doubt, that induced Huntsman to settle in Sheffield. The advantageous environment also proved to be of the greatest assistance in the rapid development of Sheffield. For example, its excellent supply of very pure water (also a

source of cheap power) was believed by some to be of special quality and efficacy in the hardening of steel. In these days of investigation, many of the old ideas on such subjects have been exploded, and probably there is nothing in Sheffield water that cannot be obtained elsewhere, at least from water showing upon analysis the same chemical composition. Yet not very long ago a considerable quantity of Sheffield was exported to America, for hardening purposes.— Abstract of an article by Mr. R. A. Hadfield, in *Cassier's Magazine* for November.

The Strength of Welds.

At the recent convention of the National Railroad Master Blacksmiths' Association, Mr. S. Uren, who has charge of the rolling mill and blacksmith shop of the Southern Pacific railway, read a valuable paper upon the subject of welding. He began with a statement of the importance of the blacksmith's work in ensuring safety in railway travel. Every important member of the engine has passed through the smith's hands, and the whole train is connected by one continuous chain of welded iron ; the smith is personally responsible for any accident that may occur through his carelessness in permitting any imperfections to pass through his hands knowingly. It is often the case that smiths will hide a defective weld by carefully hammering over the defect. Under no circumstances should this be permitted. Mr. Uren went on to state that lap welding is the usual method adopted by smiths, and when it is practicable, in his opinion, it is the best. In many cases there is not enough care taken in preparing the parts to be welded. The scarfs should be as long as can be conveniently heated, never more than a 45-degree angle. The scarfed surfaces should be slightly convex, or "high," in the center, so that when the two pieces are laid together for welding, the center will take its bearing first, as it is absolutely necessary that the center of the bar should be welded first. Prior to making the scarfs, upset the bar back as far as it will be exposed to intense heat, for the purpose of lamination over the whole length of the heated surface. as it is imperative that the iron that has been near a welding heat should be as perfectly hammered as the welded part. After the preparation of the scarfing is complete, lay the two pieces carefully in a hollow fire, and bring to the proper heat. Before laying together be sure no foreign element has adhered to the scarfed surface. In laying together, the point of one scarf should just reach the heel of the other. The weight of the hammer used to weld the two pieces must be governed by the size of the bar, as the blow should be sufficient to affect the center of the metal. With this precaution a good weld will be secured. In many cases, in testing welds by breaking transversely, Mr. Uren has found good fibrous iron in the welded sections, and crystalline metal each side of the weld. The cause of this is improper treatment of the iron back of the weld, or improper upsetting where it was brought too near a welding heat. Wrought iron becomes disintegrated to a certain extent when brought to a high heat ; consequently, if there is not sufficient metal back of the welded section to receive the necessary lamination to bring the disarranged molecules to their original position, the strength of the bar is impaired. "V" welding consists of a combination of butt and lap welding. The scarfs are formed by fitting the two pieces together at an angle of about 45 degrees. In preparing the scarfs, make the throat of the inside angle a little rounding, and the point of the outside angle to correspond. The scarfed surfaces should be a little convex across the surfaces, as in the lap weld, for the purpose of ensuring a perfect weld in the center of the bar. This method of welding is usually adopted where large pieces of

iron are required to be welded. In all cases in this class of welding the throat should be welded first by being driven together with a heavy sledge hammer, applied at the end of the bar when brought to the proper heat,— before being taken out of the fire, if practicable. "Butt" welding is simple and the work is easily prepared for it by upsetting the ends, leaving the surfaces a little convex. This method of welding requires great care in bringing the two pieces to be welded to precisely the same heat and keeping the surfaces perfectly clean.

Mr. Uren made quite a number of tests to show the relative value of the different methods of welding, and, taking the averages with those previously determined for the same iron unwelded, he gave the following statement: All butt welds showed crystalline structures on fracture, owing to the upsetting of the fibre by the nature of the weld: —

TABLE OF THE AVERAGE RESULTS OF MR. UREN'S EXPERIMENTS.

Character of Metal.	Tensile Strength.	Relative Strength.	Elongation in 8 inches.	
			Per Cent.	Relative.
Unwelded,	52,078 lbs.	1.00	22.2	1 00
Lap welded,	47,575 "	.91	19.7	.89
V welded,	46,386 "	.94	18.8	.85
Butt welded,	43,954 "	.84	8.3	.37

— *Practical Engineer.*

AMONG the November boiler explosions we note one that is particularly distressing. The gentleman owning the plant — whom we will call Mr. Brown — had been repeatedly solicited to insure his boiler, but had steadily declined to do so. He had a good engineer, he said, and a good boiler; and he didn't need insurance. Once, when our agent visited him, he was a little petulant, and his conversation was perhaps more emphatic than polite; but within a week of that day his boiler blew up and destroyed the entire plant. He felt differently about insurance after that, but when he had rebuilt his mill, and saw everything running in good shape once more, he changed his mind again and said "lightning never strikes twice in the same place." Last month the new boiler exploded with disastrous results, and Mr. Brown was himself among the killed.

DISCUSSING the window-smashing by the recent powder explosion in that city, the *Waterbury American* asks: "What made all of the broken windows fall out instead of in? Perhaps that is a simple problem, if you only know how to get at it. To the average spectator of Tuesday morning's wreck it is still a mystery. Some figure it out that the concussion first forced the windows in and that resistance of the confined air inside sent them back again with force enough to break them — as if the force of the rebound were greater than that of the original blow. Another theory presumes that the windows were drawn out by the rush of air towards the vacuum caused by the explosion. [!] This, however, does not account for the breaking of windows that faced away from the vacuum, nor for the fact that in some cases the broken windows were in the second and third stories while those on the ground floor of the same buildings were unharmed."—*Hartford Times.*

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